PROCEEDINGS

OF

THE ROYAL SOCIETY

OF

EDINBURGH.

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PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

1841. No. 19.

Monday, 1*st March* 1841.

The Right Hon. Lord GREENOCK, V.P., in the Chair.

The following Communications were read :—

1. On the Sea-Level of the Neapolitan Coast. By Sir John S. Forbes, Bart.

This paper is intended to give an account of the more recent researches of the Italian antiquaries and geologists connected with the well-known temple of Jupiter Serapis at Pozzuoli, which have been verified in several particulars by the author, by personal inspection, and extended to other parts of the western coast of Italy, where traces of marine lithophagi have been found at a height, as alleged by Niccolini, of even 250 feet above the present sea-level.

The most interesting modern observations are those of Niccolini on the actual change of relative level of the sea and land, ascertained by a fixed gauge which he has observed frequently between 1823 and 1838. In that time the land appears to have risen through a height of 112 millimetres or 4½ inches; and this change has been progressively and not suddenly effected.

2. On the Supposed Progress of Human Society from Savage to Civilized Life, as connected with the Domestication of Animals and the Cultivation of the Cerealia. By John Stark, Esq.

The object of this paper is to controvert the generally received opinion, derived from the classical writers, and adopted by most philosophers, that human society, in its original state, was one of savage barbarism; and, that, in the supposed progress from savage to civilized life, three separate stages or gradations have been gone through, the one leading necessarily to the other. These stages,—or the *hunter's life*, when the food of man was procured by the chase of wild animals, the *pastoral state*, when flocks and herds formed his chief support, and the *agricultural state*, when grains were cultivated,—the author shews never had any existence, except in the fancies of poets or the theories of philosophers.

1. In regard to the assumption that man was created a dumb savage, the author states, that such a supposition is neither reconcilable with probability, nor consonant to reason, nor warranted by historical records. If he had been originally dumb, his race never could have acquired the power of speech; if he had been merely a frugivorous animal, his instinctive propensities would never have led him to feed on animals; and if such animals were his destined prey, it could never happen, in the ordinary course of things, that he was to become their protector. If he had been created a savage, a savage he must ever have remained.

2. With regard to the domestication of animals originally wild, according to the theories of poets, philosophers, and historians, who supposed this to have been the result of ages of experiment—an assumption which has remained uncontroverted till now—the author shews that the supposition of the domesticated races ever having been in a wild state, is not warranted by any thing recorded in sacred or profane history; that, as far as human history extends, the domesticated animals were man's companions; and that an instinct of sociability, or a particular disposition to dwell with men, exists in the nature of these animals, without which all attempts to tame them would have been in vain. The animals known as domestic were so from the earliest periods, and no addition to their number has been made through successive ages.

3. The cultivation of the *Cerealia*, which, according to the philosophical theory, was an invention of civilized man, and the result likewise of ages of experiment,—the author asserts to be an assumption without the shadow of foundation. He proved, from recorded facts, that the cultivated grains are nowhere found growing in a wild state to any useful extent; that they die out in a very few years when left to the care of nature alone; that their existence depends upon their continued cultivation, and that their cultivation was known to the progenitors of the human race.

The author considers himself to have established these propositions, 1. That man was at his creation a civilized being, endowed with all the physical and intellectual powers necessary to his state as a moral and intellectual agent; 2. That the domestic animals were created for his use, and obedient to his will from the beginning; 3. That the cultivation of the Cerealia was the earliest occupation of the human race; 4. That prior to the Deluge cities were founded and many of the useful arts practised; and, 5. That the survivors of the Deluge started with all the knowledge of their predecessors, the possession of the domestic animals, and the grains necessary to their processes of agriculture.

In place of the supposed gradation from savage to civilized life, the author asserts, from the history and monuments of all ages and nations, that the general tendency of the race is to degenerate from a civilized to a barbarous state of society. And that the desolation of the mightiest kingdoms and republics of antiquity,—their ruined cities and neglected fields,—teach the lesson, that neither science nor art, neither philosophy nor religion, has hitherto been effective in stopping this downward progress,—this descent to barbarism and savage life.

The following Donations were presented :—

The Quarterly Journal of Agriculture, and the Prize-Essays and Transactions of the Highland and Agricultural Society of Scotland, for March 1841.—*By the Highland and Agricultural Society.*

On the Constitution of the Resins. Parts 4 and 5. By James F. W. Johnston, Esq., A.M., F.R.S.—*By the Author.*

15*th March*, 1841.

Dr ABERCROMBIE, V.P., in the Chair.

1. On the Parallel Roads of Glen-Roy, with an Examination of Mr Darwin's Theory of their Formation, Part I. By Sir T. D. Lauder, Bart.

2. On the Polarizability of Heat from different Sources. By Professor Forbes.

The author of this paper states in it his belief, that the curious fact formerly announced to the Society of the greater permeability of mica, laminated by heat, to heat of low temperature, contrary to the usual character of the same substance (a property which he has since extended (see Proceedings, Jan. 1840) to changes of mechanical conditions of surface), may very probably explain, as M. Melloni anticipates, the difference in point of fact long contested between them as to the equal or unequal polarizability of heat from different sources.

3. Account of the Fossil Species of the genus *Solarium*, Lamarck, found in the Supercretaceous group in Italy. By M. le Chev. Michelotti of Turin. Communicated by Dr Traill.

This genus of shells belongs to the Class Gasteropoda of Cuvier, and to the family Turbinacea of Lamarck, of which the general character is to have the shell turreted or conoid, with the aperture rounded or oblong, and the margin disunited.

M. Michelotti was induced to undertake the examination of the fossil Italian species of this genus, from the doubts prevailing regarding the identity of some of the species in the writings of authors. He describes in all ten species, which are found in the neighbourhood of Turin, of which four have not been previously noticed. The four newly described species are *Solarium neglectum*, *S. pulchellum*, *S. Lyellii*, and *S. humile*. Two of the other species described, viz. *S. Stramineum*, Lamarck and *S. luteum*, have their living prototypes,—the first in the Indian and Mediterranean Seas, and the second in the seas of New Holland. The other species are,—

Solarium pseudo-perspectivum, Brocchi.
...... umbrosum, Brongniart.
...... millegranum, Lamarck.
...... canaliculatum, Lamarck.

In illustration of his paper, M. Michelotti has sent drawings of each of the species he describes, in three different positions, so as to shew all the characters of the shell. The references to authors who have mentioned the species (or synonyms) seem very complete.

The following Donations were presented :—

Journal of the Asiatic Society of Bengal. No. 100. 1840.—*By the Society.*

Mittlere Vertheilung der Wärme auf der Erdoberfläche, nebst Bemerkungen über die Bestimmung der mittleren Temperatur. Von Wilhelm Mahlmann.—*By the Author.*

Memorie della Reale Accademia delle Scienze di Torino. (Serie Seconda). Tomo ii.—*By the Academy.*

Philosophical Transactions of the Royal Society of London for the year 1840. Parts 1, 2.—*By the Royal Society.*

Proceedings of the Royal Society 1840. Nos. 41, 42, 43, 44, and 45.—*By the Royal Society.*

Report of the Ninth Meeting of the British Association for the Advancement of Science, held at Birmingham in August 1839.—*By the British Association.*

A Supplementary Report on Meteorology, presented to the Meeting of the British Association in 1840. By Professor Forbes. —*By the Author.*

5th April, 1841.

Sir T. M. BRISBANE, Bart., G. C. B., Pres., in the Chair.

1. On the Parallel Roads of Glen-Roy, with an Examination of Mr Darwin's Theory of their Formation, Part II. By Sir T. D. Lauder, Bart.

This paper consists of a critical investigation of a recent paper by Mr Darwin upon this subject, and the author's object is to prove that Mr Darwin's views are untenable; and that his own explanation of the appearances in Glen-Roy, given in his paper

in the Transactions of this Society, and ascribing them to successive subsidences of a fresh-water lake, is still the only view reconcilable with the facts.

James Spittal, M.D., Fellow of the Royal College of Physicians of Edinburgh, was duly elected an Ordinary Fellow.

2. On the Visibility of rapidly revolving Lights, made in reference to the Improvement of Light-Houses. By Alan Stevenson, LL.B., Civil Engineer.

These experiments consisted in a comparison of the visibility of lights from lenses when at rest, and when revolving with such rapidity as to produce an apparently continuous impression on the sense of sight. They were undertaken at the suggestion of Captain Basil Hall, who had himself in the spring of last year made some trials of a similar kind, in the expectation that the eye would be so stimulated by the bright flashes, that not only the almost imperceptible intervals of darkness would have no effect in impairing the visibility of the rapidly recurring flashes, but likewise the eye would actually be stimulated by the contrast of light and darkness, in such a manner that the effect of the rapid series would be greater than that of the same quantity of light equally distributed over the whole horizon by the refracting zones at present used in fixed lights, which only refract the light in the vertical direction, without interfering with its natural horizontal divergence. Mr Stevenson shewed that this expectation was at variance with what would be predicted from a consideration of the laws of the physical distribution of the light; and the experiments proved that the visibility of the rapidly revolving series was greatly inferior, not only to that of the lens at rest, but also to that of the light equally distributed by the refracting zones. From the results of the experiments, the author drew the following general conclusions:—

1. That continuity of impression in the sense of sight is scarcely obtained by producing ten flashes in a second of time; and that the visibility of the light decreases in a most remarkable degree with the velocity of the series.

2. That this decrease of visibility, although partly owing to a loss of intensity, is chiefly caused by deficiency of volume in the visual object, which at the most rapid velocity became so small

that few observers at the distance of fourteen miles could detect it with the naked eye, while the light from the zones was large and distinct.

3. That the rapid passage of the visual object over the eye causes this decrease in its volume, by diminishing the amount of irradiation, which, according to the theory of M. Plateau, is, within certain limits, proportionate to the duration of the impulse of light in the retina.

The following Donations were presented :—

Mémoire de la Société Géologique de France. Tome iv. Ptie 1. —*By the Society.*

The Transactions of the Royal Irish Academy. Vol. xix. Part 1. —*By the Academy.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. 1841. Nos. 6, 7, 8, 9, 10.—*By the Academy.*

Proceedings of the Geological Society of London. Nos. 74 and 75.—*By the Society.*

The American Journal of Science and Arts. Conducted by Professor Silliman ; for January 1841.—*By the Editor.*

E'tudes Géologiques dans les Alpes. Par M. L. A. Necker, Tome i.—*By the Author.*

Maps of the Ordnance Survey of England and Wales. Nos. 75, 76, 79, and 82.—*By the Board of Ordnance.*

19*th April* 1841.

The Right Hon. Lord GREENOCK, V. P. in the Chair.

The following Communications were read :—

1. On the Theory and Construction of a Seismometer—an instrument for Measuring Earthquake Shocks and other Concussions. By Professor Forbes.

The plan of this instrument was submitted amongst others to a Committee of the British Association appointed to devise means for registering earthquake shocks. A heavy pendulum, suspended from a frame, will evidently have its bob left behind by its inertia when the frame is moved forwards by any concussion. To render such an instrument very sensible, however, the pendulum must be of great length, which presents many inconve-

niences in practice. The author, therefore, proposed an inverted pendulum, sustained by a steel wire, on the principle of the noddy invented by Mr Hardy, for ascertaining the stability of clock cases. The balance of gravity and elasticity (which act, the former to displace, the latter to redress, the pendulum) may be rendered as nice as we choose, and hence the sensibility of the instrument is wholly independent of its dimensions.

The author has shewn, by a mathematical investigation, that the extent of deviation due to a given concussion, within moderate limits, depends solely upon the time of vibration of the pendulum,—that, for any sudden forward motion of the machine, the greatest displacement of the bob of the pendulum may become equal to that motion,—but if the motion continue uniformly for a short space and then cease, the displacement may be doubled in amount.

The self-registering part of the apparatus consists of a pencil at the extremity of the inverted pendulum, which travels over a prepared concave surface of paper, and marks at once the direction and extent of the displacement of the pencil, which is evidently contrary to the movement of the ground. The author also points out how, by varying the position of the bob upon the rod of the pendulum, and at the same time altering the elasticity of the spring, the deviation of the pencil may be increased in any proportion to the actual movement of the ground, and this irrespectively of the dimensions of the instrument.

Lastly, he shews how, by employing two instruments of the same kind, but *whose sensibility* (determined by the time of one vibration) *differs in a known proportion*, the duration of a shock and the extent of lateral movement of the ground may be calculated; and he gives a table for this purpose. It is to be understood, however, that this and other results of the mathematical investigation are only true in so far as the fundamental hypothesis is correct,—viz. that an earthquake is a lateral movement of the ground in one direction, through a short space, and with a uniform velocity.

Similar instruments might, no doubt, be applied to measure the lateral concussions of railway trains.

2. On the Circulation of the Blood, and the Difference of the Laws of Fluids moving in living and dead tubes. Part I. By Sir Charles Bell.

The author commenced with a eulogy of Mr Hunter, and of his experiments upon the arteries; and proceeded to illustrate the elasticity and muscularity of an artery.

The author's experiments were made on the human frame, by taking advantage of the amputated limb on the instant of its separation from the body. He made a section of the artery so as to present a piece in the form of a ring,—he slit this ring, and it sprang open to a certain extent. Putting it in water, it was found in the morning reversed or bent the other way. On taking a larger portion of the artery, which was straight, and slitting it up, it immediately bent backwards in a semicircular form.

The author gave this explanation of these facts:—On the circular portion of the artery being cut up, the elastic power prevailed to a certain degree; but continuing to be opposed by the circular muscular fibres until the vital power was exhausted, then the elasticity so entirely prevailed as to bend the ring in the reverse position.

But on slitting up the long straight piece of the artery, it immediately curled back, for there are no longitudinal muscular fibres to prevent the elasticity having instant effect.

The author then went into a description of the different mode and time of action of the muscular fibre, shewing that we must not retain the idea first presented to us in the voluntary muscles, but contemplate the same property of action in the muscular fibre, where it enters into the composition of particular organs, and when it is made subservient to the function, acting in a different time and mode, and being sometimes not excitable by acrid or mechanical stimulus: hence inferring, that we must not expect to excite the muscular coat of an artery by irritating it as we might do a voluntary muscle.

The author took a portion of an artery of a square form, and found that, by appending weights, it was equally elastic in all directions; on which he argued,—Since the artery is full of blood when it receives the systole of the heart, on the acknowledged laws of hydraulics, that an impulse upon fluids is propagated equally in all directions, it must follow that the artery dilates in the transverse as well as the longitudinal direction.

He proceeded to shew, that, as the artery is elastic, the impulse of the heart cannot reach every branch at the same moment,—that undulations, or partial distention, must characterize the progress of the heart's impulse along the artery.

He argued against the opinion that there is no other quality than that of tonicity in the circular fibres of the artery. For tonicity, according to the definition of physiologists, being a permanency of action, which admits of no relaxation, it would follow that the artery had two properties exactly the same; for tonicity and elasticity would present exactly the same kind of resistance to the blood impelled by the heart.

But,—granting to these fibres the vital property of muscularity,—since the healthy action of a muscular fibre is characterized by relaxation as much as by contraction, we perceive that the higher muscularity of the extreme vessels implies that they are more easy of dilatation, as well as more powerful in contraction; and that the dilatation and contraction of successive portions of the artery must, like an increasing wave, bestow a higher degree of activity in the vessels remote from the heart. Sir Charles deferred the reading of the Second Part of his paper.

The following Donations were presented:—

The Transactions of the Linnean Society of London. Vol. xvii. Parts 2, 3, 4; and Vol. xviii. Part 1.

The Proceedings of the Linnean Society of London. Nos. 8 and 9.—*By the Society.*

Transactions of the Society for the Encouragement of Arts, Manu factures and Commerce. Vol. liii. Part 1.—*By the Society.*

Journal of the Asiatic Society of Bengal. Nos. 99, 101, and 102. —*By the Society.*

Travels in the Himalayan Provinces of Hindustàn and the Punjab. By William Moorcroft and George Trebeck. Edited by H. H. Wilson, Esq. 2 vols. 8vo.—*By the Asiatic Society of Bengal.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Tome x. Nos. 19 to 26; Tome xi. and Tome xii. Nos. 1 to 5.—*By the Academy.*

Mémoires de l'Académie Royale des Sciences de l'Institut de France. Tomes xiv. xv. xvi. and xvii.

Mémoires présentés pars divers Savants à l'Académie Royale de l'Institut de France. Tome 5.—*By the Academy.*

Voyage dans la Russie Méridionale et la Crimée. Par M. de De-

midoff. (Partie Scientifique.) Livr^{ns} xiii. et xiv. des planches. —*By the Author.*

Transactions of the Zoological Society of London. Vol. i. Part 3.

Proceedings of the Zoological Society of London. Nos. 73 to 90. —*By the Society.*

3d May 1841.

Right Hon. Lord GREENOCK, V.P., in the Chair.

The following Communications were read:—

1. Experimental Researches on the Production of Silicon from Paracyanogen. By Samuel Brown, M.D. Communicated by Dr Christison.

In his paper on Paracyanogen read to this Society at an earlier period of the present session, the author announced that he considered he had succeeded in proving, that two familiar bodies, universally believed to be distinct elements, are modifications of one and the same elementary form. In the present paper, he announced that the bodies in question are carbon and silicon, and gave a detailed statement of the investigations by which he had been led to this conclusion.

1. Silicon may be obtained from uncombined paracyanogen.—When paracyanogen, prepared from bicyanide of mercury by heat under pressure, as described in his former paper, was subjected to prolonged heat in a closed tube of German glass, a dark-brown substance was obtained, which presented all the diagnostic characters of silicon. More especially, it was incombustible before the blowpipe, underwent no change on being projected into fused chlorate of potash, but dissolved with effervescence in fused carbonate of potash, forming a white saline substance, in which silica was detected by its ordinary reagents. The same experiment was performed with the like result on a larger scale in a porcelain crucible; and the quantity of silicon produced came within a very small amount of the carbon contained, by theory, in the paracyanogen employed. When paracyanogen is heated with carbonate of potassa, silicic acid is obtained at once. A variety of experiments were described, the purpose of which was to obviate all fallacy that might be supposed to arise from silica being present in the vessels employed.

2. Siliciurets may be obtained by the reaction of paracyanogen on metals.—When bicyanide of mercury was heated in tubes

of copper or iron in the way followed for obtaining paracyanogen, the interior of the tubes was found to be lined with scales, which consisted, not of paracyanide or carburet of these metals, but of their siliciuret. And when paracyanogen was heated in a platinum crucible several times in succession till the crucible would absorb nothing more, a compound was obtained which was a siliciuret of platinum, containing four per cent. of silicon.

3. When paracyanogen is decomposed in the preceding experiments, the nitrogen given off corresponds with what is contained by theory in the compound which yields it. A variety of experiments of analysis were mentioned to this effect; from which a further corroboration was derived of the conclusion derived from the author's previous researches, that the silicon could come only from the carbon of the paracyanogen.

4. A siliciuret may be obtained from the paracyanide of iron. Under this section, the author first described the process by which a pure paracyanide of iron may be obtained from ferrocyanide of potassium; and stated that he had found this compound to consist of one equivalent of nitrogen, two of carbon, and one of iron. He then observed that he had been led to suppose this compound to be the true compound radicle of the so-called ferrocyanides; on which subject he proposed to make ere long a distinct communication to the society. He next proceeded to explain the results of numerous experiments on the influence of heat on the paracyanide of iron; from which it appeared that, under a high temperature and pressure, a compound was obtained, in which carbon could not be detected, but instead of it silicon, in the proportion of 28.5 per cent. To these remarks were added others on ferrocyanide of potassium, which he considers to be resolved in the process into cyanide of potassium evolved by sublimation, and paracyanide of iron, which at the same time is decomposed, and yields disiliciuret of iron. The product obtained in these two ways is in general partly in the form of a coaly powder, partly in fused obsidian-like masses. But if the ferrocyanide of potassium be heated with its own weight of cyanide of potassium, as a non-reactive flux, the disiliciuret is obtained in a semicrystalline form, which in fine powder is colourless, and is seen before the microscope to be transparent like glass; and sometimes there is an approach to a crystalline form, nay, small particles may be discovered with the microscope which are regular octahedres. The disiliciurets of iron thus produced were treated of by the author in

his Inaugural Dissertation in 1839, as carburets of the metal. (See Trans. Brit. Assoc. 1839, vol. ix.) Experiments were added under the present section, which satisfied the author that every conceivable source of silicon, except from the paracyanogen, was provided against by the manner in which the experiments of conversion were performed. Among other facts thus elicited, it appeared, that, by successive operations in the same vessel, a greater weight of disiliciuret of iron might be obtained than the weight of the vessel itself.

5. Silicic acid may be obtained by a direct process from the paracyanide of iron. The conversion thus accomplished might appear, as the author conceived, more satisfactory to most persons, than any of the previous operations, on account of the large scale on which the experiments were performed. When paracyanide of iron was mixed with four times its weight of carbonate of potash, and ignited in a shut crucible of hammered iron for four hours at a full white heat, a rose-red saline product was formed, from which a transparent solution was obtained with water; and when this was supersaturated by hydrochloric acid, a bulky precipitate was thrown down, which, when purified from adhering metallic oxide by fusion with carbonate of potash, solution of the product in water, neutralization with hydrochloric acid, evaporation, desiccation, and ignition, and elutriation with water to remove chloride of potassium,—presented all the distinctive characters, physical as well as chemical, of silicic acid. Five grains of paracyanide of iron thus gave 3.04 of silicic acid; and 30 grains of ferrocyanide of potassium, similarly treated, gave 5.4 grains of silicic acid. The iron crucible used in these operations did not yield a particle of silicic acid when heated to a white heat with pure carbonate of potash,—the same salt employed in the preceding cases of conversion. A large crucible was worked seven successive times with 9334 grains in all of ferrocyanide of potassium; and 1240 grains of silicic acid were produced.

The author added that, in the course of several of these operations, more especially those of the last section, he found the iron to undergo conversion as well as the carbon; and in a subsequent paper he proposes to state in detail the facts which lead him to the conclusion that this metal is a variety of the same elementary form with rhodium.

2. On the Anatomy of the *Amphioxus lanceolatus* of Yarrell. By John Goodsir, Esq. Communicated by Professor Syme.

After a short statement of the labours of Yarrell, Couch, Retzius, and Müller, the author gave a detailed description of the structure of *Amphioxus*, as observed in the dissection of one of two specimens taken by Mr Forbes in the Irish Sea. The abdominal folds, and the anterior and posterior anal fins, were described, and the existence of a fin in front of the anus illustrated by an observation made by Professor Agassiz, of the temporary existence of a similar fin in the embryos of certain fresh-water fishes.

The osseous system presented two divisions,—the true or neuro-skeleton, and the intestinal or splanchno-skeleton. The true skeleton consisted of a chorda dorsalis, equally pointed at both extremities, without the slightest trace of a cranium, and destitute of any of the peripheral vertebral elements, with the exception of a row of cells—germs of interspinous bones and fin-rays—along the base of the dorsal and anal fins. The tissue of this neuro-skeleton was not even cartilaginous, consisting merely of membrane and globular nuclei, derived from the original elementary cells. The splanchno-skeleton consisted of a hyoid apparatus, and of 70 to 80 pairs of elastic filamentous ribs. The hyoid apparatus—in two divisions, with 17 pieces in each—exhibited 34 rays, pointing inwards, and each springing from one of the 34 basal elements of the hyoid bone. These rays the author looked upon as developments of the tubercles and teeth of the central aspect of the branchial apparatus of the higher fishes, and not as branchiostegal rays. The ribs were enveloped in the mucous membrane of the intestine, and each alternate pair bifurcated below, to enclose the abdominal longitudinal vessel or heart. From these circumstances, and from other considerations, the author looked upon the ribs of *Amphioxus* not as true ribs, but as splanchno-ribs—repetitions of the hyoid bone—analogues of the tracheal and bronchial cartilages of the higher Vertebrata. The tissue of the splanchno-skeleton is more advanced than that of the neuro-skeleton; the ribs are cartilaginous; the hyoid bones hollow cartilages, with isolated cells or nuclei in their interior.

The nervous system presents nothing more than a spinal cord, without a trace of cerebral development, and from 60 to 70 pairs of spinal nerves. The spinal cord was in the form of a ribbon, pointed at both ends, with a dorsal median groove, and a line of black or grey matter; was composed of nucleated cells, without

tubes or fibres, and gave origin to the nerves in single roots only. The nerves were all symmetrical, dividing into dorsal and ventral branches. The second pair sent back a dorsal and a ventral branch, to join the corresponding branches of the other nerves, along the sides of the body, and along the bases of the dorsal and anal fins; from which distribution the author was inclined to believe, that although the second pair in *Amphioxus* presented certain resemblances to the vagus, it was, in reality, the trifacial.

The vascular system consisted of a straight abdominal vessel, the branchial artery or heart, without any trace of valves or division into cavities. This vessel sent off lateral branches, which, passing up on the internal surface of the intestine, along the ribs, communicated by a capillary respiratory system of vessels with a dorsal trunk or aorta.

The intestinal tube was straight from mouth to anus, its anterior half dilated, strengthened by ribs as described above, and its entrance guarded by the hyoid rays. This dilated portion of the canal received sea-water, as in the *Ascidiæ*, to act on the respiratory vascular ramifications on its internal surface, which is undoubtedly ciliated in the living animal. The digestive portion of the canal is narrow, and presents not a trace of a liver, or of any other assistant chylo-poietic viscus.

As there was no trace of branchial fissures—as the ribs were too numerous to be looked upon as true branchial arches (branchial arches alternating with branchial fissures)—and as the other organic systems were in the condition of those of an embryo before the appearance of branchial clefts, the author was led to the conclusion that the *Amphioxus* had never had, at any period of its existence, branchial clefts;—that it was an animal which had arrived at its perfect development before the branchial clefts had appeared, and, consequently, with an undeveloped osseous and nervous system, without a liver, and with an unilocular heart.

After examining the generative organs, and other departments of its anatomy, the author entered upon the consideration of the zoological position of *Amphioxus*, which he observed could no longer be ranked with *Petromyzon* and *Myxine*, but must take an ordinal place in any new arrangement of the class. In conclusion, he remarked, that although genera allied to *Amphioxus* might now be rare, yet in the ages which have passed since the development of organic forms commenced, *Abranchiated* fishes may have been more common, and may yet afford subjects of research to the palæontologist

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

1841–1842. No. 19.

Monday, 6th December 1841.

Sir T. M. BRISBANE, Bart., President, in the Chair.

The following communications were read :—

1. On the Circulation of the Blood, and the Difference of the Laws of Fluids moving in Living and Dead Tubes. Part Second. By Sir Charles Bell.

He recommenced with the statement of the difference with which water flowed from a reservoir through tubes of equal calibre, but unequal lengths; and of the effect of pressure on elastic tubes, shewing that the impediment to the transmission of fluid through them was proportioned to their length. He stated that the obstruction at the turn of a tube, was proportioned to the acuteness of the angle. He then inferred that the arteries were in circumstances to render the delivery of blood unequal, unless there was a living property additional to the hydraulic laws.

Then, referring to the effect of capillary attraction, he argued, that if the law prevailed in the animal body as in dead tubes, then, on estimating the length of vessels of capillary size, and the attraction existing between solid and fluid, the circulation could not go on.

He then stated the surprising living qualities in the animal sur-

faces, of repelling, attracting, selecting; hence inferring, that in the surface of the arteries, there did not prevail that attraction which caused the capillary phenomena in dead tubes.

Proceeding to illustrate his position by the phenomena exhibited by the microscope, and by the occurrences familiar to the surgeon during operation, he concluded that the inner surface of the bloodvessels had an influence on the blood contained, of preserving it fluid, and of resisting attraction: But that, when the vitality of their coats was diminished or disturbed, as by the violent tearing of the artery; then coagulation of the blood, and attraction of the blood to the sides of the artery, took place, by which the hæmorrage was stopped.

2. On a Peculiar Structure observed by the Author in the Ice of Glaciers. By Professor Forbes.

This structure, which appears to have escaped the notice of authors on the subject, is a veined or ribboned appearance which pervades the whole ice of many glaciers. The veins or bands are occasioned by the alternation of ice more or less compact; that which is porous approaching to white or whitish green, the denser ice having a bluish tint. The thickness varies from a fraction of an inch to several inches, and the parallelism may be considered as complete through considerable spaces. It extends in more or less complete development from the *névé*, or uncompacted glacier, down to the inferior termination; and during the greater part of this space, in the case of the lower glacier of the Aar, the bands were parallel to the lofty walls by which the glacier was bounded laterally; their position was generally vertical, but sloping from below upwards and outwards as the distance from the sides of the glacier diminished. Towards the lower end of the glacier the structure became very obscure, and for a time nearly vanished. It appears, however, that these bands or veins change their direction from longitudinal to transverse, their outcropping being parallel to the end of the glacier, the apparent strata there dipping inwards at an angle of 10° or 20°. It is this appearance which has given rise to the mistaken idea of horizontal stratification in glaciers. The veined structure rises towards the sides or supporting walls, and has altogether the appearance of being determined by the contour of the ice, and perhaps by the lines of greatest pressure in its interior. In the case of the lower part of the glacier of the Rhone, the veined structure forms conical sur-

faces, widening upwards, and more and more obtuse as we recede from the centre of pressure, from which the descending glacier is spread out in all directions; its extension producing fissures which extend like radii, and which appear to be always perpendicular to the direction of the structural planes.

Without attempting to explain the process by which so peculiar and interesting a phenomenon is produced, the author remarks, that its existence and production is highly important in two points of view:—(1.) As defining in some respects the nature of icy structure in glaciers, which has been so keenly contested by later writers, and on which so much of the theory of the progression of glaciers depends; and, (2.) As illustrating by analogy the mysterious geological phenomena of cleavage planes, which have been attempted to be accounted for by the presence and energy of polar and crystalline forces, without any evidence having been adduced how such a structure could result from them. The structure of a glacier is daily forming; its analysis falls within the proper domain of physical inquiry; and however hopeless direct experiments in the laboratory must be on such a subject, the required evidence may be perhaps attained by the careful study of glacier crystallization.

James Kinnear, Esq., recommended by Dr Borthwick, was duly elected an Ordinary Fellow.

The following Donations were reported as having been received since the close of last Session:—

Astrononomical Observations made at the Royal Observatory, Greenwich, in the years 1838 and 1839, under the direction of George Riddell Airy, Esq. 2 Vols.—*By the Royal Society of London.*

Journal of the Royal Geographical Society of London. Vol. x. Part 3.—*By the Society.*

Report of the Tenth Meeting of the British Association for the Advancement of Science, held at Glasgow in August 1840. —*By the British Association.*

Bulletin de la Société Géologique de France. Tome x. Feuilles 24–29. Tome xi. et Tome xii. Feuilles 1–11.—*By the Society.*

Proceedings of the Meteorological Society during the Sessions 1838–39 and 1839–40.—*By the Society.*

Quarterly Journal of the Statistical Society. Vol. iv. Part 1–2. —*By the Society.*

Proceedings of the American Philosophical Society. Nos. 14, 15, 16, 17, 18.—*By the Society.*

Transactions of the American Philosophical Society, held at Philadelphia, for Promoting Useful Knowledge. New Series. Vol. vii. Parts 2, 3.—*By the Society.*

Flora Batava. No. 122.—*By the King of Holland.*

Produzioni relative al Programma di tre quistioni Geometriche proposto da un nostro professore.—*By the Author.*

Problema Fondamentale per le polari Coniche Reciproche Geometricamente Risoluto da Nicola Trudi.—*By the Author.*

Boston Journal of Natural History, containing Papers and Communications read to the Boston Society of Natural History, and published by their direction. Vols. i. ii. and vol. iii., Parts 1, 2, 3.—*By the Boston Society of Natural History.*

The Quarterly Journal of Agriculture; and the Prize Essays and Transactions of the Highland and Agricultural Society of Scotland. Nos. 53, 54, and 55.—*By the Highland and Agricultural Society.*

The American Journal of Science and Arts, conducted by Professor Silliman and Benjamin Silliman jun. For April, July, and October 1841.—*By the Editors.*

Lectures on Agricultural Chemistry and Geology. By James F. W. Johnston. Nos. 1 to 11.—*By the Author.*

Mémoire sur la Chaleur Solaire, sur les pouvoirs Rayonnants et Absorbants de l'air atmospherique, et sur la temperature de l'Espace. Par M. Pouillet.—*By the Author.*

Bulletin de la Société d'Encouragement pour l'Industrie Nationale pour 1840.—*By the Society.*

The Article on the Silurian System, from the Edinburgh Review for April 1841. By W. H. Fitton, Esq.—*By the Author.*

Catalogue de l'Ecole des Vignes de la Pepiniere du Luxembourg. —*Par le Duc Decaze.*

Commentatio de usu Experientiarum Metallurgicarum ad disquisitiones Geologicas adjuvandas. Auctore J. F. L. Hausmann.—*By the Author.*

Illustrations of the Affinity of the Latin Language to the Gaelic or Celtic of Scotland. By T. Stratton, Esq.—*By the Author.*

Madras Journal of Literature and Science. April to September 1840.—*By the Madras Literary Society.*

Mémoires de la Société Geologique de France. Tome iii. and Tome iv. premiere partie.—*By the Society.*

Proceedings of the London Electrical Society. Session 1841-42. Nos. 1, 2.

The Transactions and the Proceedings of the London Electrical Society. Vol. i.—*By the Society.*

Tijdschrift voor Natuurlijke Geschiedenis en Physiologie. Uitgegeven door J. Van Der Hoeven, M.D., en W. H. De Vriese, M.D. Deel viii. St. 2, 3.—*By the Editors.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Tome xii. Nos. 25, 26, et Tome xiii. Nos. 1–18. —*By the Academy.*

Traité Elémentaire des Fonctions Elliptiques. Par P. F. Verhulst.—*By the Author.*

Analyse Raisonnée des Travaux de Georges Cuvier, Précédée de son Elogé. Par P. Flourens.—*By the Author.*

Des moyens de soustraire l'Exploitation des Mines de Houille aux chances d'explosion. Recueil de Memoires et de Rapports publié par l'Academie Royale des Sciences et Belles Lettres de Bruxelles.

Annuaire de l'Observatoire Royal de Bruxelles, pour l'an 1841. Par le Directeur, A. Quetelet.

Annuaire de l'Académie Royale des Sciences et Belles Lettres de Bruxelles. 1841.

Bulletin de l'Académie Royale de Bruxelles. Tome vii. Nos. 9, 10, 11, 12. Tome viii. Nos. 1–6.

Nouveaux Memoires de l'Académie Royale des Sciences et Belles Lettres de Bruxelles. Tome xiii.

Memoires Couronnés par l'Académie Royale des Sciences et Belles Lettres de Bruxelles. Tome xiv.—*By the Academy.*

Annuaire Magnetique et Meteorologique du Corps des Ingenieurs des Mines de Russie pour l'année 1839. Par A. T. Kupffer. —*By the Author.*

The Eighth Annual Report of the Royal Cornwall Polytechnic Society. 1840.—*By the Society.*

Journal of the Asiatic Society of Bengal. Nos. 105, 106, 107, 108, 109, 110, 111.—*By the Society.*

Proceedings of the Geological Society of London. No. 76.

Transactions of the Geological Society of London. New Series. Vol. vi. Part 1.—*By the Society.*

Bulletin de la Société de Geographie. Deuxieme Serie. Tomes 13, 14, 15.—*By the Society.*

Recueil de Voyages et de Memoires publié par la Société de Géographie. Tome vi.—*By the Society.*

Natuurkundige Verhandelingen van de Hollandsche Maatschappij der Wetenschappen te Haarlem. (Second Series.) Deel i.—*By the Society.*

The Oily Acids, forming the first Supplement to the Seventh Edition of Dr Turner's Chemistry. By Justus Liebig, M.D., and William Gregory, M.D.—*By the Editors.*

Annuaire du Journal des Mines de Russie, pour les Années 1835, 36, 37, et 38, et Introduction. 5 Tomes.—*By General Tchefskine.*

Transactions of the Botanical Society of Edinburgh. Vol. i. Parts 1, 2.

Fourth and Fifth Annual Reports and Proceedings of the Botanical Society of Edinburgh.—*By the Society.*

Eighteenth Report of the Whitby Literary and Philosophical Society, presented at the Annual Meeting, November 4. 1840. —*By the Society.*

Dictionarium Anamitico-Latinum, primitus inceptum ab illustrissimo et Reverendissimo P. J. Pigneaux, Vicario Apostolico Cocincinæ, et dein absolutum et editum a J. L. Taberd, Episcopo Isauropolitano, &c.—*By the Editor.*

Dictionarium Latino-Anamiticum, auctore J. L. Taberd, Episcopo Isauropolitano, &c.—*By the Author.*

Abstract of the Magnetic Observations made at the Trevandrum Observatory, during the month of May 1841. By John Caldecott, Esq., Director.—*By the Author.*

Museo Numismatico Lavy appartenente alla R. Accademia delle Scienze di Torino. Parts 1, 2.—*By Chevalier P. Lavy.*

Descriptive Account of the Antiquities and Coins of Affghanistan. By H. H. Wilson.—*By the Honourable the Directors of the E. I. C.*

Archives de l' Electricité. Par N. A. de la Rive. No. 1.—*By the Author.*

Det Kengelige Danske Videnskabernes Selskabs Naturvidenskabelige og Mathematiske Afhandlinger. 8 Vols.—*By the Academy.*

An Abridgement of the Acts of the Parliament of Scotland from 1424 to 1707. By William Alexander, Esq., W.S , F.R.S.E. *By the Author.*

Transactions of the Philosophical Society of Cambridge. Vol. vii. Part 2.—*By the Society.*

Annals of the Lyceum of Natural History of New York. Vols. i. ii. iii. iv. Parts 1, 2, 3, and 4.—*By the Directors of the Lyceum.*

Voyage dans la Russie Méridionale et la Crimée. Par M. Anatole de Demidoff. Planches. Livns 6, 7.—*By the Author.*

Commentationes Societatis Regiæ Scientiarum Gottingensis Recentiores. Vols. 7 and 8.—*By the Society.*

Reports presented to the Legislature of the Commonwealth of Massachusetts on Wheat and Silk, Invertebrate Animals, Herbaceous Plants and Quadrupeds.—*By the Bowditch Family.*

Æsop's Fables, written in Chinese by the learned Mun Mooy Seen-Shang. Translated by Robert Thom, Esq.—*By the Translator.*

Ancient Laws and Institutes of Wales.—*By the Commissioners on Public Records.*

Novorum Actorum Academiæ Cæsareæ Leopoldino-Carolinæ Naturæ Curiosorum. Vol. 18. Supplement.—*By the Academy.*

Monografia de genere Murex ossia enumerazione delle principali specie. Per Giov. Michelotti.—*By the Author.*

List of the Instruments and Apparatus belonging to the Royal Society.

List of the Portraits in possession of the Royal Society.

Report of the Committee of Physics, including Meteorology, on the objects of Scientific Inquiry in those Sciences.

Catalogue of the Scientific Books in the Library of the Royal Society.

Catalogues of the Miscellaneous Manuscripts and of the Manuscript Letters in the possession of the Royal Society.

Statutes of the Royal Society. 1840.

Proceedings of the Royal Society of London. Nos. 46, 47, 48.

Philosophical Transactions of the Royal Society of London for 1841. Part 1.

Astronomical Observations made at the Royal Observatory, Edinburgh. Vol. 4. By Thomas Henderson, F. R. SS. L. & E., &c. —*By the Royal Society of London.*

Rara Mathematica; or, a Collection of Treatises on the Mathematics and Subjects connected with them. Edited by J. O. Halliwell.—*By the Editor.*

Mémoire sur differens Procédés d'Integration. Par J. Plana, à Turin.—*By the Author.*

Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin. 1839.

Bericht über die zur Bekanntmachung geeigneten Verhandlungen

der Konigl. Preuss. Akedemie der Wissenschaften zu Berlin. Juli 1840 bis Juni 1841.—*By the Academy.*

The American Almanac and Repository of Useful Knowledge for 1841.—*By the Phil. Society of America.*

Proceedings of the Zoological Society. Oct. 13. 1840 to July 27. 1841.—*By the Society.*

Letter-Press to the First Part of the Natural History and Illustrations of the Scottish Salmonidæ. By Sir William Jardine, Bart.—*By the Author.*

Ordnance Survey of Ireland. County Galway.—*By His Excellency the Lord Lieutenant.*

Monday, 20th December.

Dr HOPE, V.P. in the Chair.

The following communications were read:—

1. Report of a Committee on the Papers of David Hume, bequeathed to the Society by the late Baron Hume. Communicated by the Council.

The Committee to whose examination the papers bequeathed to the Royal Society of Edinburgh by the late Baron Hume, has been intrusted, in the view of suggesting what might be the most proper and useful plan for their future disposal, consistently with the peculiar character and functions of the learned body to which they now belong, having proceeded to examine their contents with care, have now to offer, though not without considerable hesitation, the views that have occurred to them.

Independently of some valuable and interesting autographs of Mr David Hume, to be mentioned in the sequel, the important part of this bequest, to which the attention of the Committee has been more particularly directed, consists of a miscellaneous and very broken mass of letters, which may, in general, be described as the Private and Confidential Correspondence of that illustrious philosopher and historian. Of these letters, about one hundred and forty-five are written by Mr Hume; the number of those addressed to him is about five hundred and fifty; making a total of nearly seven hundred letters.

Mr Hume's epistolary correspondents appear to have been very numerous, especially in the later periods of his life, when his literary fame had been established, and he had become personally known in a

very extensive circle of acquaintance both at home and abroad; among whom are to be found many persons of the most distinguished ranks in society, as well as of the highest eminence in science and learning. In many instances, indeed, the letters addressed to Mr Hume are little more than complimentary expressions of homage to an illustrious writer, and derive any interest they possess from the evidence they afford of the extensive diffusion of his fame as a philosopher and historian. But the greater and more valuable part of the collection consists of the correspondence of those with whom he lived on terms of intimate friendship, to whom he was in the habit of communicating his thoughts and feelings with a singular degree of openness and playful simplicity, and by whom he appears to have been beloved and caressed with a fondness of attachment that affords the most pleasing testimony to the truthfulness and amiability of his character in private life, and a striking contrast to the impressions that may have been received by those to whom Mr Hume is known only in his metaphysical and historical writings. The letters, in general, are not controversial or discursive; there are occasionally introduced discussions on topics of permanent interest; but even in his correspondence with those to whom his peculiar opinions were the most offensive, there prevails the same mutual kindliness and forbearance with which he appears to have inspired his more intimate associates.

Such being the general character and description of the papers in question, it appears to your Committee that the value they possess is chiefly to be derived from the illustrations they might furnish of the literary history of Mr Hume. Whatever diversity of opinion may exist as to the tendency of his philosophical or political speculations, it must on all hands be admitted that he has attained, and must continue to occupy, a station in the literature of his country that cannot fail to make the formation of his character and the progress of his literary labours to be regarded as objects of more than ordinary interest. In that view, these papers may be justly esteemed of great value. The series is indeed very imperfect, and probably its defects cannot now be fully supplied from any other sources; but enough is preserved to throw some curious and interesting lights on even the earliest period of Mr Hume's career; and the materials may here be found for tracing his subsequent progress through life with the most minute accuracy.

In what manner these materials ought now to be employed, is a question which, to your Committee, appears to be of considerable difficulty. In the terms of Baron Hume's bequest, no particular

object or definite purpose is expressed; nor, in the ultimate disposal of these papers, has the Society been fettered by any limitations or conditions. His motives, however, in selecting the Society as the depositary of these remains of his illustrious kinsman, must have been at once to secure their preservation in the most effectual manner, and to prevent any injudicious or indiscreet use of them, to the risk of which they might otherwise have been exposed.

In discharging the duty imposed on the Society by their acceptance of this bequest, there can be no doubt that the whole of the documents thus acquired must be carefully and faithfully preserved. It may be true that in the general mass there are some articles apparently of little value, which may have owed their preservation to accident or oversight; but your Committee can by no means encourage the idea, that in attempting to separate these from what they might deem truly valuable, the Society would be safe in exercising any discretion whatever; for, most assuredly, however judicious the selection might be, it would not fail to expose them hereafter to misrepresentation and reproach.

On the more difficult question as to the disposal of these manuscripts, the Committee have not arrived at any clear or decided opinion. Thus far, indeed, they conceive it to be evident, in the first place, that the property must remain inalienably in the Society, and that to convert it into a subject of pecuniary speculation would be an abuse of the confidence reposed in them by the testator; and in the second place, that to undertake directly, and in their own name, the publication of the whole or of any portion of these manuscripts, would not be in accordance with the proper character and functions of that learned Body. If in these respects the views entertained by the Committee shall be deemed correct, the only obvious alternative seems to be, to await the opportunity of entrusting the use of these manuscripts to an Editor, who may in all respects be thought worthy of the confidence of the Society, and who may intend to employ them either as the Illustrations of a Life of Mr Hume, or as a separate publication of his Private and Confidential Correspondence. There appears to your Committee to be no good reason for any hurry or impatience in accomplishing such an arrangement; and, in the mean time, it is obviously proper that these papers should be accessible to the inspection of such persons, Members of the Society or others, as may apply to the Council of the Society for that purpose; all due precautions being taken against any abuse of the liberty so to be conceded.

Having said so much on what the Committee regard as the more

important portion of the Hume Papers, it remains to take notice, in a few words, of the other parts of this bequest. Among these there is what may be regarded as in the nature of a Common-place Book, written evidently at an early period, which would be found to furnish some useful hints to a biographer in tracing the progress of Mr Hume's studies, and the formation of his opinions. Besides these, and a few other miscellaneous papers of no great importance, there are the original manuscripts of the earlier part of the History of England, of the Dialogues on Natural Religion, and of his own Life. Of these, the chief value is derived from the highly instructive exhibition they afford of the infinite care and pains with which Mr Hume revised and corrected all his compositions, and by means of which he succeeded in giving to his style not only its minute accuracy, but much also of its characteristical force and spirit. The successive editions of his works are well known to afford abundant evidence of his uncommon anxiety and care in these respects, and their collation has been found to furnish most useful lessons to the students of English style; but in these manuscripts the process of revisal and correction becomes still more apparent and remarkable, and renders them of considerable curiosity.

THO. THOMSON.
JOHN ABERCROMBIE, M.D.
ALEX. MACONOCHIE.
JAMES PILLANS.
JOHN SINCLAIR.

The following postscript has since been added by order of the Council :—

POSTSCRIPT.

It may be proper to add to the statements in the preceding Report, that among the original letters comprehended in Baron Hume's bequest, there are a few that have already been printed. Of these, the most important are some of the letters relative to Mr Hume's ill-fated connection with M. Rousseau, published either at the time by himself and others, or in a volume entitled his Private Correspondence, printed at London in 1820. The only others here deserving of particular notice are a few of the letters written by Mr Hume near the close of his life, and communicated by Baron Hume to the editor of the Literary Gazette, and published in London in the year 1821. It is scarcely necessary to add, that there still exist many other

valuable letters of Mr Hume, the originals of which had not come into the possession of his executors, and that a considerable number of these have appeared in various biographical and periodical publications.

2. On the Optical Properties of Greenockite, by Sir David Brewster, in a letter to Lord Greenock.

Greenockite has the form of a regular six-sided prism, with pyramidal summits, the faces of the pyramid being inclined 36° 20′ to their base. The pyramids are sometimes truncated on their summit.

The crystallization is often composite.

The index of refraction of Greenockite is 2.6882, corresponding to the middle of the green space, and to the ordinary ray. Hence Greenockite exceeds the *Diamond* in refractive power, and also *chromate of lead*, which I had found to surpass the diamond in this respect.

The double refraction of Greenockite is comparatively small, which is not usual in substances of a high refractive power. It is so small, indeed, that owing to its great dispersive power it is exceedingly difficult to separate the two images.

The polarising angle of Greenockite is 68° 36′ for the *red* rays, which corresponds to an index of refraction for that light of 2.5517.

I found it very difficult to establish the existence of an *uniaxal* system of rays along the axis of the prism; but I succeeded in doing this by light of the condensed rays of the sun, by which it can alone be established; for when in biaxal crystals one of the axes is very weak, as in nitre, its influence on the rays is scarcely visible in crystals of little thickness, such as those we meet with in Greenockite.

The uniaxal system of rings is *negative*, as in calcareous spar.

The light left at the polarising angle is blue and pink.

Professor Forbes, after reading the foregoing communication, remarked that the uniaxal structure of Greenockite was ascertained by himself with the aid of concentrated gas-light, and that his notice on the subject was published in the Philosophical Magazine for July 1840.

3. On the Results of the most recent Experiments on the Conducting Power for Heat of different Soils. By Professor Forbes.

The author gave, in continuation of a former paper (see Proceedings of the Royal Society of Edinburgh, 3d Dec. 1838), an account of the continued systematic prosecution and annual reduction of the observations of temperature at different depths (3, 6, 12, and 24 French feet) below the surface of the ground, in various geological formations near Edinburgh, viz. the trap rock of the Calton Hill, the incoherent sand of the Experimental Garden, and the coal formation sandstone of Craigleith Quarry. The weekly observations at all these stations have been projected into curves, which present the most remarkable concordance of general features for the four years now complete, and give a just confidence in the comparability of the results obtained. The thermometric readings have all been rigorously corrected for the expansion of the alcohol in the tubes; and, starting from these data, the results in the following tables have been obtained, partly by graphical methods, partly by calculation. The quantity marked A is the log. range at the surface. The quantity B (which is the most interesting result) marks the rate of diminution of the range as we descend, and is proportional to the square root of the specific heat of the soil divided by its conducting power. M. Regnault of Paris has kindly undertaken to determine the specific heats by direct experiment, whence the conductivity will become known; and the comparison of the results for four years proves that we have already obtained a near approximation to its value, which is well defined for the different formations, but especially for the Sandstone, when contrasted with the other two. The results of Tables III. IV. and V. are deduced from the numbers in Table I.; and for the sake of comparability with the foreign observations, the French foot and centigrade degree have been employed as units. So well do the observations of the different thermometers for any one station accord together, that, taking any two of the thermometers and combining their results by pairs, we should obtain nearly the same conclusions. These conclusions are also in accordance with those which the Epochs in Table II., and the rate of Progress of Heat downwards in Table VI., present; the best conducting soil (that for which B has the smallest numerical value) transmitting the heat fastest.

TABLE I.—Range in Centigrade Degrees.

	3 Feet.			6 Feet.			12 Feet.			24 Feet.		
	Trap.	Sand.	Sandst.	Trap.	Sand.	Sandst.	Trap.	Sand.	Sandst.	Trap.	Sand.	Sandst.
1837	10.53	11.23	9.58	6.61	8.30	7.72	3.05	4.19	5.22	0.80	1.16	2.28
1838	9.83	11.30	10.29	6.22	8.10	7.91	2.80	3.94	5.16	0.70	1.0	2.13
1839	8.64	10.55	9.14	5.73	7.76	7.40	2.69	3.95	4.64	0.76	0.79	2.20
1840	8.29	10.14	18.98	5.70	7.35	7.28	2.50	3.72	4.63	0.89	1.06	2.07

TABLE II.—Epochs of Minima.

1838	Feb. 26	Mar. 3	Feb. 23	Mar. 14	Mar. 19	Mar. 3	Apr. 20	Apr. 22	Mar. 20	July 18	July 8	May 12
1839	Mar. 14	Feb. 24	Feb. 24	Mar. 27	Mar. 25	Mar. 4	Apr. 30	Apr. 22	Apr. 1	July 12	June 24	May 12
1840	Mar. 1	Feb. 25	Mar. 1	Mar. 14	Mar. 15	Mar. 8	Apr. 19	Apr. 18	Mar. 21	July 5	June 26	Apr. 30

Epochs of Maxima.

1837	Aug. 6	July 31	Aug. 5	Sept. 2	Aug. 24	Aug. 19	Oct. 17	Oct. 6	Sept. 11	Jan. 8	Dec. 30	Nov. 11
1838	Aug. 8	Aug. 6	Aug. 16	Sept. 6	Aug. 31	Aug. 23	Oct. 19	Oct. 14	Sept. 19	Jan. 5	Jan. 4	Nov. 2
1839	Aug. 1	July 30	July 30	Aug. 26	Aug. 19	Aug. 14	Oct. 10	Oct. 3	Sept. 11	Jan. 8	Dec. 26	Nov. 4
1840	Aug. 23	Aug. 18	Aug. 18	Sept. 4	Sept. 2	Aug. 23	Oct. 6	Sept. 30	Sept. 9	Jan. 3	Dec. 18	Oct. 26

TABLE III.—Values of A.

	Trap.	Sand.	Sandstone.
1837	1·164	1·176	1·076
1838	1·173	1·217	1·114
1839	1·086	1·182	1.049
1840	1·073	1·155	1·044

TABLE IV.—Values of B.

1837	—·0545	—·0440	—.0316
1838	—·0641	—·0517	—·0345
1839	—·0516	—·0498	—·0305
1840	—·0550	—·0470	—·0308

TABLE V.—Annual range reduced to 0·01 Cent.

1837	58·1 F. Feet.	72·2 F. Feet.	97·3 F. Feet.
1838	49·3	61·8	91·
1839	59·2	63·5	100·
1840	55·9	67·1	98·8

TABLE VI.—Velocity of Propagation of Heat downwards.

Maxima.

		Trap.	Sand.	Sandstone.
1837	1 foot (French) in	7·5 days.	7.1 days.	4·9 days.
1838		6·8	6·8	3·6
1839		7·8	7·2	4·6
1840		6·6	5·95	3·5

Minima.

		Trap.	Sand.	Sandstone.
1838	1 foot in	6·5 days.	5·8 days.	3·6 days.
1839		6·0	5·1	3·6
1840		6.1	5·7	3·05

James Thomson, Esq., Civil Engineer, proposed by Dr Thomas Thomson of Glasgow, was duly elected an Ordinary Fellow of the Society.

The following Donations were presented to the Society since last Meeting :—

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Tome xiii. Nos. 19, 20, 21.—*By the Academy.*

Verhandelingen over de Natuurlijke Geschiedenis der Nederlandsche Overzeesche Bezittingen, door de Leden der Natuerkundige Commissie in Oost Indie en Andere Schrijvers. Afleverings 1, 2, 3.

Nouveaux Mémoires de l'Académie Royale des Sciences et Belles Lettres de Bruxelles. Tome xiv.—*By the Academy.*

Mémoires couronnés par l'Académie Royale des Sciences et Belles Lettres de Bruxelles. Tome xv. Ptie. 1.—*By the Academy.*

Astronomische Beobachtungen auf der Königlichen Universitäts Sternwarte in Königsberg. Von F. W. Bessel. 20te Abtheilung.—*By the Author.*

Proceedings of the Royal Society. No. 49.

Catalogue of Miscellaneous Literature in the Library of the Royal Society. 8vo.—*By the Society.*

An Account of the Vegetation of the Outer Hebrides. By J. H. Balfour, M.D., F.R.S.E.—*By the Author.*

Descriptive and Illustrated Catalogue of the Physiological Series of Comparative Anatomy contained in the Museum of the Royal College of Surgeons in London. Vols. 4, 5. 4to.—*By the Royal College of Surgeons.*

Monday, 3d January 1842.

Dr HOPE, V.P. in the Chair.

The following communications were read :—

1. On the Cultivation of the Sugar-Cane in Spain. By Dr Traill.

He prefaced it by a short sketch of the knowledge which the ancients had of this plant, of its introduction into Europe, and from thence into the American Islands. He endeavoured to shew, from Spanish authorities, that very soon after the discovery of America, the Spaniards carried the sugar-cane, among other useful plants, with them to the West Indies, and sedulously

cultivated it; and he considered the speculations of *Labat* and *Lafitau*, on the supposed American origin of the cane, as very inconclusive.

The author's remarks on the Spanish cultivation of the cane were the results of his personal observations during a residence of some months in Spain in the year 1814, and of some statistical information afforded to him by the late Wm. Kirkpatrick, Esq. of Malaga. The sugar-cane culture was introduced by the Moors, soon after their conquest of Spain, and flourished exceedingly even after the overthrow of their empire in the Peninsula. Its first serious check was from the cruel and impolitic expulsion of the Moriscoes in 1609; its second, from the enormous extension of sugar plantations in the West Indies and South America. Yet, notwithstanding the capricious oppressions of a tyrannical government, it has subsisted to the present time as a considerable branch of Spanish agriculture, with periodic fluctuations in its prosperity, for two hundred years since the expulsion of the most industrious inhabitants of Spain.

He described the district producing sugar, at the period of his visit, as extending along the shores of the Mediterranean, from *Adra* to *Manilba*, a distance of 130 miles. The breadth of this track, however, is small—not more, on an average, than four or five miles, being hemmed in on the west and north by the rugged mountains of Andalusia. These ranges screen it from the west and north winds; but as the most lofty are crowned with perennial snow, occasional frosts are injurious to the sugar planter. The general climate of Andalusia was shewn by Dr T. to be remarkably mild throughout the year; as is proved by the luxuriant growth of *Chamærops humilis*, *Cactus Opuntia*, *Agave Americana*, the orange and the lemon, and the date-palm, in Southern Andalusia.

Along the track in question there are many sugar plantations, and a considerable number of sugar-mills, moved either by water or by mules. Most of the plantations are small; but one estate made 4600 loaves of white sugar annually, each of the value of ten dollars. Most of the Spanish sugar, however, was either *Muscovado* or *clayed* sugar. The statistical remarks shewed that a well-managed estate, near Marbella, returned in the worst years 7 per cent. on the capital employed, in middling years 11 per cent., and in good years from 16 to 20 per cent., after deducting all charges.

2. On the Theory of the Parallel Roads in the Glens of Lochaber. By Sir G. S. Mackenzie, Bart.

Sir George Mackenzie read a paper on the Theory of the Parallel Shelves in the Glens of Lochaber, in which he first noticed the objections to the theories that ascribed the origin of these appearances to fresh-water lakes, the barriers of which had been destroyed at different periods; and to the ordinary action of the sea when the land was at a lower level than at present. The causes supposed to have removed the barriers, in the first case, being violent disruptions, the preservation of level and parallelism is totally inconsistent with such operations. In the second case, the shelves being confined to the single locality of these glens, while, supposing them to have been sea-beaches, the appearances of such shelves should be frequent and to be seen every where; it becomes necessary that the elevation of the land should have been confined to a narrow locality, and to have exhibited a boundary no where to be found. In this case, also, the elevation of the land must have been sudden, otherwise the traces of the action of the sea would have been seen continuous all over the sides of the glens. Sudden elevation being therefore necessary, it is not at all probable that the levels and parallelism could have been preserved so perfectly as to be in accordance with the curvature of the earth.

Sir George alluded to the researches of Sir James Hall in reference to the debacle or flood that appears to have passed over the country; and to the notions of Professor Agassiz, that ice, a universal glacier, had produced the phenomena which had been attributed to the debacle. He denied that these phenomena could have been the effects of glaciers properly so called; though, as stated by him in a paper read last session, masses of ice may have been, and most probably were, brought from the Arctic Regions by the debacle, and may have been arrested in the narrow passes among the mountains, forming temporary glaciers, if such an appellation may be applied to them, and producing effects not easily accounted for without such assistance. Sir George then pointed out a singularity in the localities of the Lochaber glens, in reference to the demonstrated course of the debacle, which had led him to attribute to that catastrophe the formation of the shelves. The openings of the glens face that course, and they turn towards the north, so as to become nearly parallel to the Great Glen. The highest summit level is between Glen Gluoy and Glen Roy, and the other lower summit levels are between Glen Roy, Glen Spean,

and the valley of the Spey. The debacle coming from the NW. would fill these glens, and flow over the summit levels. As soon as it subsided below that of Glen Gluoy, that glen would be in the condition of a lake or arm of the sea, and defended from the great tumult of waters by the mountain ridge betwixt it and the Great Glen, while the agitation would be sufficient quickly to produce the highest of the shelves. When the waters subsided below the summit level of Glen Roy, then the highest shelf in that glen would begin to be formed. As the subsidences would be irregular, in consequence of the agitation of the waters, and the influence of the varied surface of the land, and as also the tides would contribute in a considerable degree to this irregularity, Sir George conceived a sudden subsidence, and a sudden stoppage for a time, amply sufficient for the formation of the imperfect terraces or shelves, the sections of which clearly indicate something very different from the comparatively tranquil operations of the sea on the coast. The lowest shelf appears to have formed on the subsidence of the water below the summit level betwixt Glen Spean and the valley of the Spey. The shelves disappear at the points where the agitation of the waters may be supposed to have been too great for their formation, on account of vicinity to the Great Glen; and, consequently, we may expect the diluvium to assume the appearance in that locality which it exhibits in many others, and modified by the shape of the surface. This modification is beautifully exhibited whenever the effects of the land on the movement of the waters is taken into account, and which it has never been sufficiently, when the theory of a debacle has been discussed.

Sir George admitted fully the probability that masses of ice, brought by the debacle, may have rested at the openings of these glens, and acted as barriers to a certain extent; but this, he considered, does not affect his general theory, while it rather strengthens it. The erratic blocks found on the shelves may have been deposited by ice; and if rounded pebbles, brought in evidence by Mr Darwin against Sir George's theory, could not have been produced by such a vast torrent, the great abundance of ready-made pebbles to be found in the masses of conglomerate over which the flood had to pass, would sufficiently remove the objection. Sir George expressed himself as by no means anxious about the fate of his theory, because a philosophical examination of it, if condemnatory, would remove obstacles in the way of arriving at truth; and if laudatory, would lead to a correct explanation of facts still in a somewhat anomalous state.

3. On the Results obtained with different forms of Rain-Gauges. By Joseph Atkinson, Esq. Communicated by David Milne, Esq.

The objects proposed were—

First, To discover the difference, which the *height* of Rain-Gauges above the surface makes in the amount of rain received by each gauge.

Second, To try the effect of an *Inclined* Funnel, which always presents itself towards the wind.

Third, To test the action of a *Globular* Gauge or Sphere.

Fourth, To investigate whether any and what difference the *size* of the funnel made in the quantity of rain received.

The number of gauges used to accomplish these objects was six;—of which three were horizontal funnels, 12 inches in diameter, placed respectively 0, 3, and 6 feet above the surface; one was a copper sphere, 36 inches in circumference, placed 6 feet above the surface; one was a funnel, 12 inches in diameter, placed at an angle of about 45 degrees, and 6 feet above the surface—a vane was attached to the rim of this funnel, and this last moved upon a pivot over the receiver; and the sixth gauge had a funnel of 18 inches diameter, placed horizontally, and six feet above the surface.

The results obtained from these gauges in twelve months, beginning with November 1840, were as follows:—

First, The excess of the surface gauge over that which was three feet above the ground, was nearly identical with the excess of the latter over that which was six feet above; the excess in the first mentioned case being 1.816 inches—in the latter, 1.865 inches.

Second, The inclined and moveable funnel always took more rain than the horizontal funnel on the same level during strong winds, and less during calm winds. The difference between these two gauges was, in twelve months, only 1.887 inches. In that period, the horizontal funnel on the surface had taken 1.804 inches more rain than the inclined funnel, the latter being placed 6 feet above the surface.

Third, The globular gauge, instead of receiving more rain than the common horizontal funnel at the same level, as might have been expected, received 0.560 inches less in the twelve months. In the first six months, it received more rain than the horizontal funnel, but during the warm months it received considerably less. During the cool months it represented very fairly the mean of the

horizontal funnel and the inclined funnel; but during the summer months it failed in doing so, that failure being greatest in August, when it had taken 0.536 inches less than the mean of the other two gauges. In the twelve months the globular gauge had taken 1.503 inches less than the mean of the other two gauges.

Fourth, The funnel, which had a diameter of 18 inches, received 2.505 inches less rain than a funnel 12 inches in diameter, which was placed at the same height. And this difference was not the effect of one or two months; for it will be observed, on reference to the Table, that the quantity received by the larger funnel was uniformly less than the quantity received by the smaller.

These results were obtained at Harraby, near Carlisle.

NUMERICAL RESULTS—SUMMARY.

1840–1.	12-inch Funnel on the Surface. — 1.	12-inch Funnel 3 feet above Surface. — 2.	12-inch Funnel, horizontal, 6 feet above Surface. — 3.	12-inch Funnel at an angle, and with Vane, 6 feet above Surface. — 4.	Sphere, 36 inches in circumference, 6 feet above Surface. — 5.	18-inch Funnel, horizontal, 6 feet above Surface. — 6.
Nov.	3.089	3.112	2.709	3.158	2.877	2.709
Dec.	0.439	0.429	0.369	0.393	0.405	0.291
Jan.	3.182	2.594	2.364	2.668	2.560	2.129
Feb.	1.569	1.477	1.249	1.681	1.337	1.167
March.	2.728	2.571	2.407	3.550	3.042	2.153
April.	2.587	2.576	2.429	2.915	2.481	2.324
May.	2.406	2.261	2.172	2.435	2.181	2.074
June.	3.380	3.405	3.243	3.193	2.882	3.013
July.	3.270	3.180	3.166	2.666	2.717	2.902
Aug.	6.597	6.456	6.210	5.651	5.394	5.780
Sept.	3.941	3.901	3.863	3.405	3.507	3.377
Oct.	6.035	5.444	5.360	5.713	5.598	5.117
	39.222	37.406	35.541	37.428	34.981	33.036

The sum of the Sphere (5.) *less* than the mean of the Horizontal and Vane (3. and 4.) by 1.503.

The sum of the Surface (1.) *more* than the sum of the Vane (4.) by 1.804.

The sum of the 18-inch Funnel (6.) *less* than the sum of the 12-inch Funnel (3.) by 2.505.

The following Donations were presented to the Society since the last meeting:—

Mémoires de l'Académie Imperiale des Sciences de Saint Petersbourg. (Sciences Mathematiques et Physiques.) Tome ii. Livns 5, 6.

Do. do. (Sciences Naturelles.) Tome iii. Livns 5, 6, et Tome iv. Livns 1, 5.

Do. do. (Sciences Politiques, Histoire, Philologie.) Tome v. Livns 1, 4.

Do. do. (Par divers Savans, et lus dans ses Assemblées.) Tome iv. Livns 3, 4.

Recueil des Actes de la Séance Publique de l'Académie Impériale des Sciences de Saint-Petersbourg, ténue le 29 Dec. 1840.—*By the Imperial Academy.*

Bullétin de la Société Imperiale des Naturalistes de Moscow, 1840. Nos. 1, 4, et 1841. No. 1.—*By the Society.*

Ueber den Galvanismus als chemisches Heilmittel gegen örtliche Krankheiten, von Dr Gustav Crusell.—*By the Author.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

1841-42. No. 20.

Monday, 17*th January* 1842.

Dr ABERCROMBIE, V. P. in the Chair.

The following communications were read:—

1. On the Identity of the Animal Matters which form the Basis of the Animal Fluids and Solids. By James Stark, M.D., F.R.C. Phys.

The author, after referring to the late researches of Mulder, Vogel, Liebig, &c., whose experiments proved the close analogy between albumen, fibrin, and casein, and their almost identity in composition, stated that, in consequence of some experiments he had performed a few years ago, he was led to entertain the idea that all the animal fluids and solids consist of modifications of one and the same prototype animal matter. The following considerations seemed to confirm this opinion.

1. Experiments on the blood, and the fact of all tissues of the body, however differing in appearance and chemical properties, being formed from that albuminous fluid. 2. The formation of the chick in ovo, albumen and oil being the only matters from which all the tissues and fluids are derived; whilst the chick being shut up in a calcareous covering and tough membrane, which becomes denser as incubation advances, would appear to prevent any of the usual

supposed changes being produced, which could allow albumen to be converted into gelatin. 3. The continuity of tendon and muscle. The author stated, that if a fine fibre of tendon be carefully removed, it brings away with it its continuation in the muscle, or *vice versa*, and that, when this was examined by means of a powerful microscope, the continuity of the ultimate fibres appeared to him to be capable of being traced. 4. The mode in which a ruptured tendon is repaired,—the fibrinous matter which is thrown out, apparently by simple condensation, seeming to assume all the characters of true tendon. 5. The early food of the young of all the Mammalia, consisting, like that of the chick in ovo, of a kind of albuminous matter and oil, viz. milk. 6. Experiments on the nutrition of animals, which shew, that though fed with gelatin, fibrin, and albumen, the lacteals contain a simply albuminous fluid. 7. The similar effects produced by maceration on all the tissues of the body.

The author then briefly narrated the chemical details, which satisfied him that all the solids and fluids of the body (fatty and nervous matters excepted), might be reduced to a prototype or basic animal matter, which exhibited none of the characters naturally belonging to any of the fluids of the body; and he shewed how the albumen in the serum of the blood seemed to be instantly resolved into this basic animal matter by a few drops of solution of caustic potash. He also found that the potash solution had a similar action on all the constituents of the blood, the fibrine as well as the albuminous matters not only preventing the blood from clotting but also from depositing its red or coloured particles. The author pointed out the effect of ether in removing this basic animal matter in a state of purity from its chemical solutions, and remarked that it acted similarly on solutions of albumen and of gelatin. He also stated, that this prototype animal matter appeared, in certain states of the system, to be secreted in its basic form along with the urine, and had been formerly described by him under the name of Gravidine.

The author therefore proposed to adopt from Mulder, for this basic animal matter, the name of *Protein*, as expressing the Proteus-like forms it is capable of assuming.

The author next proceeded to observe, that being desirous of ascertaining what effect chemical agents exerted on the tissues of the body in producing their solution, he was induced to examine the solutions by means of a powerful microscope, with a magnifying power of 800 diameters. He then observed that these

were composed of an infinite number of minute globular particles floating in the clear fluid. These globules were many times smaller than the globules of the blood, and from their very minute size the author was only able to guess at their diameter. These globules, in the author's opinion, are not to be confounded with those described by Edwards, Baer, Sir E. Home, and others, who also stated the tissues to be composed of globular parts; because the globules of these observers were of the same size as the blood corpuscles. These minute globules the author regarded as the ultimate particles of animal organization; and though they seemed to consist of an external coat, and an enclosed transparent fluid, he thinks this is a deceptive appearance, and that it is more likely the particles are solid, as they apparently remain unchanged in size or form on drying. When the animal matters were removed from their chemical solutions in a state of purity by means of ether, and again examined, the author stated that these minute globular particles were even more distinctly seen than before, and that they retained their original globular appearance and general character apparently unchanged. He also stated that the blood to which potash had been added, was wholly reduced to its component globular particles floating either singly or in small irregular agglomerations; but not a single blood corpuscle was visible; all had been apparently resolved into thin constituent globular particles.

The author then stated, that he was induced to extend his examinations to the natural solids and fluids of the body, in order to ascertain whether any similar globular appearance could be detected in them. On a careful examination, almost all the tissues seemed to him to be composed of filaments of extreme tenuity, of the very same diameter as the minute globules he had previously observed in the chemical solutions; and these filaments could, in many instances, be seen to be formed of globules or molecules arranged in lines. When the fibre or membrane was stretched, the globular or molecular appearance of the filaments appeared to be destroyed, but, when relaxed, the peculiar appearance became again distinctly visible.

On examining the fluids of the animal body, the author remarked that the fluid fibrin which rises to the top of new-drawn blood was composed of a multitude of minute globules of the same size and appearance as those previously seen in the tissues and in the chemical solutions. He further conceives, from his microscopic examinations, that the corpuscles of the blood are very compound bodies,

composed of the same minute globules arranged in concentric rings. The serum of the blood of the lower animals also seemed to him to be filled with minute very transparent globules, but those in human serum were not always so easily detected. The pus and mucus corpuscles were also described as consisting of agglomerations of similar minute globules. The casein globules were also described.

The author stated that his observations had been made with a very excellent common compound microscope, but that he had verified every observation by means of crystal lenses of high power, simple globules of crystal, a garnet lens, with a magnifying power of 1000 diameters, and a Wollaston's doublet, adapted to the microscope.

2. On the Parasitic Fungi found growing on the Bodies of Living Animals. By John Hughes Bennett, M.D. Communicated by Dr Graham. Part 1. *See Proceedings of the next Meeting.*

The following Donations were presented to the Society since last Meeting.

Ordnance Survey of the County of Wexford in Ireland. 56 sheets. —*By his Excellency the Lord Lieutenant.*

Proceedings of the Linnean Society of London. Nos. 10, 11, and 12.

Transactions of the Linnean Society of London. Vol. xviii. part 4. —*By the Society.*

Monday, 7th February.

Sir T. M. BRISBANE, Bart., President, in the Chair.

The following communications were read :—

1. On the Parasitic Fungi found growing on the Bodies of Living Animals. By John Hughes Bennett, M. D. Communicated by Dr Graham. Part 2.

The author's object was, 1*st*, To confirm and extend the investigations of Gruby concerning the mycodermatous vegetations growing in the crusts of the cutaneous disease called *Porrigo lupinosa* ;—2*d*, To describe a plant he had himself found growing on the living membrane and tubercular matter of *Phthisis pulmonalis* ;—3*d*, To describe the structure of a plant found infesting the skin and gills of

the gold-fish ;—and, 4*th*, To inquire into the pathological state which furnishes the conditions necessary for the growth of fungi in living animals.

1. In July last, the author examined the crusts of *Porrigo lupinosa*, readily detected the cylindrical and ramified appearances described by Gruby, and confirmed his account of the development of the disease. In some cases, the appearance of the crusts containing the vegetations was preceded by pustules; but as nothing of the kind would be observed in other instances, this seems an accidental, not an essential character of the disorder. The crusts appear in seven or eight days, in the form of minute, yellow, depressed spots, consisting of a smooth, cup-shaped capsule. This capsule, as seen with a magnifying power of 300 diameters, gives off from an amorphous granular matter numerous jointed tubes, which discharge from their extremities many round or oval bodies, the sporules or prolific germs of the plant. The appearance of the Porrigo-capsule was always preceded by desquamation of the cuticle. Hence it is probable that the sporules insinuate themselves into the crevices, instead of springing up originally below the cuticle, or in its substance, as Gruby supposes. The author was not more successful than Gruby, in communicating the disease by inoculation ; but nevertheless considers that the doctrine of its contagious nature, generally held by medical men, is sufficiently proved by other evidence. He thinks it is not confined to the human race only, as he has lately detected precisely the same appearances on the face of a common house-mouse.

2. While investigating the nature of pulmonary tubercles, the author observed a vegetable structure in the sputa expectorated during life, as well as in the tubercular matter found in the lungs after death, in a case of phthisis with pneumothorax. The structure consisted of jointed tubes branching dichotomously, between $\frac{1}{100}$ and $\frac{1}{200}$ of a millimetre in diameter, and springing from an amorphous granular mass. They gave off round or oval corpuscles, which appeared to be sporules, arranged in bead-like rows. These vegetations seemed to have existed during life, both because they were seen in fresh sputa, and because those seen in the lungs could scarcely have attained their actual development in the short space of thirty-six hours, which elapsed between the patient's death and the examination of the body. The plants resembled Link's *Penicillium glaucum*.

3. The gold-fish is known to be subject to a disease, accompanied

with the formation of a cottony substance around its gills, and on other parts of its body. In a specimen put into his possession by Mr Goodsir, the author found that the cottony substance presented under the microscope both a cellular and a non-cellular structure. The former consisted of long tubes divided into elongated cells, at the proximal end of which there was a transparent vesicle or nucleus about a 100th of a millimetre in diameter. Some cells were filled with a granular matter; others were empty, as if they had discharged their contents. Besides this structure, there were also long filaments, about a 600th of a millimetre in diameter, which sprung from the tubes, and seemed to consist of a diaphanous sheath, and a solid transparent matter. This structure, as in the two previous instances, sprung from a finely granular amorphous mass.

The author next gave a condensed view of the history of his subject, describing more especially the observations and discoveries of Bassi, Audouin, and Johanys relative to the Muscardine, or fungous disease, of silk-worms,—those of Hannover and Stilling, on the Confervæ which infest reptiles,—those of Ehrenberg, Goodsir, and Cooper, on the mycodermatous vegetables of fishes,—those of Owen and Deslongchamps, on birds,—and those of Schœnlein, Fuchs, and Langenbeck, Gruby, and others, on man. And from all the facts hitherto collected on the subject, he inferred, that the vegetations in question are not the cause, but the result of disease in animals,—that they grow on unorganized matters, apparently albuminous or tubercular in nature, which are effused into the healthy textures,—that they occur only in animals previously weakened by circumstances inducing imperfect nutrition,—and that their growth is to be counteracted partly by invigorating the body and partly by local applications hostile to vegetable life.

The paper was accompanied with drawings of the appearances described.

2. On the Action of Water on Lead. By Dr Christison.

The author, after briefly stating the results of his Experimental Inquiries, published on this subject in 1829, proceeded to describe two instances which had recently come under his notice, illustrative of the solvent action of certain terrestrial waters on lead, and of the danger of using this metal for conducting water in pipes, unless with a due regard to the circumstances which promote or prevent its corroding property. In one instance, the water of a spring, conveyed

in a lead-pipe from a distance of three quarters of a mile, was found to act so powerfully on the lead, that in a short time the cistern in which the water was collected became covered with loose carbonate of lead, and the metal could easily be detected in the state of oxide dissolved in the water. In this case, the action was found to depend on the spring being of extraordinary purity, its total saline ingredients being only a 22,000th part. In the other instance, water conveyed half a mile in a lead-pipe, was impregnated exactly in the same way, and with the very same phenomena,—but with the additional circumstance, that, in consequence of the impregnation not having been detected in time, as in the previous case, the disease, *Colica pictonum*, broke out in the house supplied with the water. In this case, the water was by no means pure, as it was found to contain no less than a 4,500th part of saline matter. But there was scarcely any other salt present except muriates, which the author had ascertained in his former researches not to prevent the action of water on lead, unless present in much larger quantity.

He next proceeded to explain in what manner the action of the water was put an end to in both these cases. In similar instances, the only remedy formerly thought of was the substitution of iron-pipes. In the former of the two cases which fell under his notice, the water was left at rest in the pipe for four months, till a firm crust of mixed carbonate and sulphate of lead had crystallized on the lead; after which no farther action took place. In the latter instance, the same end was attained by keeping the pipe full of a solution of phosphate of soda, consisting of a 27,000th of the salt.

The author appended an analysis of the compound formed by the action of distilled water on lead. Guyton-Morveau and others considered it a hydrated oxide; the author himself, in 1829, thought it a neutral carbonate; and, in 1834, Captain Yorke first considered it a hydrated oxide, and eventually concluded from his analyses, that it is an irregular mixture of hydrated oxide and carbonate of lead. The author finds that the product is a hydrated oxide, when the action goes on without the access of carbonic acid; but that, when the action proceeds in the usual way, under exposure to the atmosphere, the product is a crystalline body, of which the primitive form seems to be the regular octahedre, and which is composed of two equivalents of neutral carbonate, united with one equivalent of hydrated oxide ($2\ PbO\ CO^2 + PbO\ Aq$).

He then stated the following to be the general conclusions to be

drawn in a practical point of view, from his present and previous inquiries as to the use of lead for conveying water:—

1. Lead-pipes ought not to be used for the purpose of conveying water, at least where the distance is considerable, without a careful chemical examination of the water to be transmitted.

2. The risk of a dangerous impregnation with lead is greatest in the instance of the purest waters.

3. Water, which tarnishes polished lead, when left at rest upon it in a glass vessel for a few hours, cannot be safely transmitted through lead-pipes without certain precautions.

4. Water, which contains less than about an 8000th of salts in solution, cannot be safely conducted in lead-pipes, without certain precautions.

5. Even this proportion will prove insufficient to prevent corrosion, unless a considerable part of the saline matter consist of carbonates and sulphates, especially the former.

6. So large a proportion as a 4000th, probably even a considerably larger proportion, will be insufficient, if the salts in solution be in a great measure muriates.

7. In all cases, even though the composition of the water seems to bring it within the conditions of safety now stated, an attentive examination should be made of the water, after it has been running for a few days through the pipes. For it is not improbable, that other circumstances, besides those hitherto ascertained, may modify the preventive influence of the neutral salts.

8. When the water is judged to be of a kind which is likely to attack lead-pipes, or when it actually flows through them impregnated with lead, a remedy may be found, either in leaving the pipes full of the water, and at rest for three or four months, or by substituting for the water a weak solution of phosphate of soda, in the proportion of about a 25,000th part.

The following Donations were presented to the Society since last Meeting.

Proceedings of the American Philosophical Society. Vol. ii. No. 19. —*By the Society.*

Laws, Regulations, and Annual Report of the Leeds Philosophical Society for 1840–41.—*By the Society.*

Journal of the Asiatic Society of Bengal, 1841. Nos. 112, 113, and 114.— *By the Society.*

Ordnance Survey Maps of England and Wales. Nos. 77, 78, and 87.—*By the Master-General of the Ordnance.*

Karten der Isothermen-Curven auf der Nordl. Hemisphære. Von Wilh. Mahlmann.—*By the Author.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Tome xiii. Nos. 22, 26. Tome xiv. Nos. 1, 2, 3. —*By the Academy.*

Monday, 22d February.

The Right Hon. LORD GREENOCK, V.P., in the Chair.

1. On the Necessity of the Sense of Muscular Action to the full Exercise of the Organs of the Senses. By Sir Charles Bell, K.H.

Referring to the nerves of touch, as distributed to the points of the fingers, the author proceeded to shew that something more was necessary than the exposure of the nerve. For example, the tongue being the most perfect organ of touch, resulting from the fine supply of nerves, is yet incapable of receiving certain impressions;—so that although it could distinguish the finest hair, so fine as not to be felt by the finger, yet if applied to the artery at the wrist, it conveys no sense of pulsation.

Part, therefore, of the organization of the finger consists of a ball of elastic matter, under the nerves, peculiarly suited for receiving pulsation; and being moulded by pressure, by this means conveying the sensation of form. It could not be that the variety in sensation results from the depth to which the impression is conveyed, for the nerves of sensation are on the surface, and the deeper parts do not feel. It must then be the change or moulding of the elastic cushion, consequent on pressure, that is conveyed to the nerve.

After shewing that weight so little different as that of a sovereign and a shilling could be distinguished when placed on the tip of the finger (although no distinction could be made when the pieces of money are laid upon any other part of the surface of the body, however delicate the sensation), he went on to shew the happy combination of the muscular action of the hand and fingers with these *palpi*.

Referring to the sense of muscular action, he gave reasons for the opinion that we had a consciousness of it independent of the sense of touch, or of any of the other senses. He illustrated this by the

effect of a species of paralysis, in which the sense of muscular motion was lost, whilst the power of action remained.

Referring to the experiments of Weber and others, by pricking the skin, he stated, that on pricking certain parts of the body with two sharp points at the same moment, there was a sensation of one point only, whilst, on other parts, the sensation of the two points was distinct. Those experimenters drew the conclusion that this capacity of distinguishing the two points resulted from the greater concourse of nervous filaments. He stated, on the contrary, that the capacity of distinguishing the two points, or, in fact, of distinguishing the form of bodies, did not result from the mere sensibility of the part; for example, that the back of the hand was painfully pricked, and yet was not capable of distinguishing the two points from the one. He contended, on the contrary, that the capacity resulted from the junction of sensibility and motion. It was limited to the hand, the tongue, and the lip.

Pricking the cheek with two points gave no distinct sensation, but on approaching the lower lip the points become distinct. And not only the sensibility to *form*, but to *weight* also, results from the combination of muscular motion. Hence the sovereign and the shilling may be distinguished by their weight on being placed on the lip or tongue, though not by any less moveable part.

The author proceeded to consider the motions of the eye, arguing, that to the full exercise of the organ in vision the action of the recti muscles of the eye was necessary, and that a sense of their action was combined with the impression on the retina.

After some instances drawn from the *musci volitantes*, and the experiments of Dr Wells, he stated, that when the impression was permanent on the spot of the retina, the eye being closed, the perception of place was received from the sense of the action of the recti muscles. But if the ball of the eye was moved by the point of the finger, or by the oblique muscles, there was no apparent change in the place of the image. On this subject, he referred to the case of the *nystagmus bulbi*, in which there was an incessant motion of the eyeball, whilst the person saw distinctly, and could perform most minute works with the needle or the pencil.

The fact on which the author placed the greatest stress was the effect of cutting one of the recti muscles. He referred to a late

volume of the Phil. Trans. of London, descriptive of a case, in which a lad, blind from birth, had at eighteen years of age the sight of one eye restored. But the eye being distorted towards the nose, the rectus internus muscle was cut across. The consequence of this was, that he no longer saw objects in their right position. They appeared placed to that side on which the muscle had been cut. The author's explanation is, that the tendon of the muscle being cut off from its attachment to the ball of the eye, the muscle contracted, and sensibility to this contraction being associated with the impression on the retina, produced a false perception of the place of objects.

The author concluded by expressing his doubt whether his course of study fitted him to be a competent judge of some of those matters. He could not resist the conclusion, that these required the exercise of a double sense, and an operation of the mind of the nature of comparison, to rouse to consciousness and the knowledge of external existences.

2. Geological Notes on the Alps of Dauphiné. By Professor Forbes. Part 1st. *See Proceedings of the next Meeting.*

The following Gentlemen were duly elected Ordinary Fellows of the Society :—

John Davy, M.D.;
Robert Nasmyth, Esq., F.R.C., Surg.

The following Donations were presented to the Society since the last Meeting :—

Twelfth Report of the Scarborough Philosophical Society. 1841. —*By the Society.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Tome xiv. Nos. 4, 5, 6, 7.—*By the Academy.*

Report of the Commissioners appointed to consider the steps to be taken for Restoration of the Standards of Weight and Measure.—*By the Commissioners.*

Letter to the Right Honourable George Earl of Aberdeen, on the State of the Schools of Chemistry, in the United Kingdom. By W. Gregory, M.D., F.R.S.E., &c.—*By the Author.*

A faithful Record of the Miraculous Case of Mary Jobson. By W. Reid Clanny, M.D., F.R.S.E.—*By the Author.*

Bien-Etre et Concorde des Classes du Peuple Français. Par Le Baron Charles Dupin.—*By the Author.*

Vie d'un Bienfaiteur du Peuple, A. P. de la Rochefoucauld. Par Le Baron Charles Dupin.—*By the Author.*

Monday, 7th March.

Sir T. M. BRISBANE, Bart., President, in the Chair.

1. On the most recent Disturbance of the Crust of the Earth, in respect to its suggesting a Hypothesis to account for the Origin of Glaciers. By Sir George Mackenzie, Bart.

In this paper the author pointed out that the force, which had protruded granite and other matter among the strata, could not have been the same in point of time with that which broke up the crust of the earth into its present shape; because the matter in veins which we now see exposed to view on the faces of precipices, having been fluid at the time of protrusion, must have run out of the fissures on the rock being raised up. It appeared, therefore, that all matter filling fissures in rocks, had become solid before the most recent cataclysm had taken place. There being no appearance of any matter having been protruded from below at the time of the surface being forced into its present disrupted state, it was assumed that the expanding force which broke the crust, was that of vapourable matter, chiefly steam, confined between the solid crust and the igneous mass in the interior; and also filling up the place of the enormous masses of matter which had been, at a former period, forced up from below, and which we now see in the shape of veins and dykes, and also of those very extensive ranges of country wholly composed of trap beds, admitted to have been submarine lavas. The vapourable matter having increased, and also its expansive force, the crust at length yielded; and the vapourable matter being set free, two consequences were supposed to have followed. First, the vapourable matter must have carried with it a vast amount of heat, so as to cause a considerable refrigeration of the broken crust, and to which its exposure to atmospheric influences, and perhaps also to the rushing of the waters, would contribute. Secondly, supposing the cataclysm to have taken place in the winter season, the extraordinary quantity of vapour forced by

expansive impulse into the atmosphere, would speedily arrive at a region whence it would fall back in a frozen state. This would probably have taken place even in the summer season, at least in so far as to load the mountain summits and valleys lifted above the line of perpetual congelation. A change of climate having been effected by the disruption of the crust, the winter influences would, for a long time, have greater power, so that the whole surface within the sphere of a cataclysm might have become covered with ice, until the crust should begin to recover its temperature from the internal source of heat, and the influence of the sun conjointly. The author supposed that, on account of the surface having had, probably, but little elevation previous to the cataclysm, the heat of the crust was so considerable, as, joined to the influence of the sun, to be sufficient to have induced on the temperate zone a climate more nearly allied to that of the tropics, and such as to have admitted of the residence of those animals requiring a comparatively warm climate, and whose remains have given rise to much difficulty in geological speculations. As a subsidiary source of vapour, the author supposed that at the moment of the cataclysm, much water would have been admitted to contact with the interior heated surface. He was not aware, at the time he read his paper, that in a recent work by Charpentier on glaciers, this geologist had appealed to the same thing as the only source of the vapour ; so that the author's hypothesis of the escape of pent up vapour, as the chief source for producing glaciers, still remains his own ; and in conjunction with that of Charpentier, it seems to furnish a theory of glaciers, which, in the present state of discussion respecting glacial action, is a desideratum.

2. Geological Notes on the Alps of Dauphiné. By Professor Forbes. Part 2d.

The district proposed to be described, in so far as it was studied by the author in two journeys in 1839 and 1841, is an out-lyer or appendage to the main Alpine chain, which occupies a considerable portion of the old province of Dauphiné, and the modern departments of the *Hautes Alpes* and *Isére*. It is bounded, roughly, by the rivers Arc and Isére on the north, and by the Durance and the Drac in other directions. Its nucleus is essentially granitic, against which sedimentary deposits of limestone, of different ages, and especially of lias and chalk, repose in highly elevated or contorted strata ; and

it not unfrequently happens, that the dislocation of strata has been so great, that the gneiss or granite rocks are superimposed upon the secondary formations.

The granitic mountains of Oisans, which are amongst the highest of the second order of European chains, attain a greater elevation at their culminating point, the Mont Pelvoux, than any of the Alps between Mont Blanc and the Mediterranean. Even Mont Iseran and Monte Viso are surpassed in height by this summit, which measures 13,468 English feet. The ravines by which the chain is intersected have a corresponding depth and ruggedness, so that the *cols*, or passages from one valley to another, are generally covered with perpetual ice and snow, and present, besides, more continuous and inaccessible precipices than are common in any part of Switzerland. The author shortly described several journeys made through the central part of this district, in which it became necessary to cross *cols* of above 10,000 feet in height, from whence alone an intimate knowledge of the structure of these mountains can be obtained.

Guided by the interesting memoir of M. Elie de Beaumont, on the geology of the *Montagnes d'Oisans*, and by the admirable map of Bourcet, he was enabled, in a great many particulars, to verify the observations of the first named distinguished geologist, especially as refers to the phenomena visible at the contact of the calcareous and granitic rocks, which left no doubt on the author's mind that the superposition of the latter to the former is undeniably true. No more can it be doubted, that, as M. E. de Beaumont affirms, we have here evidence of the extensive elevation of previously deposited sedimentary rocks, probably by the appearance from below of the granite itself. Professor Forbes feels some hesitation in admitting, with M. de Beaumont, the *crateriform* nature of this elevation, as indicated by a *quâ-quâ-versal* dip of the stratified rocks round a central point in the neighbourhood of the Mont Pelvoux, and by the radiation of the vallies from that centre. He considers that the observations of the great French geologist, when analyzed, as well as his own, rather point to an anti-clinal axis passing through the point in question, and prolonged in a NN.W. and SS.E. direction; accompanied, however, with various minor lines or centres of dislocation, especially that which elevated the mountain of Grande Rousse to the northward, of which the geology has been ably described by M. Dausse. The interference of this elevation with the previous

one (roughly parallel to the torrent of the Veneau), probably produced the excessive disturbance of the strata of lias near La Grave, which have been jostled between the two granite masses.

These views are supported, partly by a consideration of the external *contour* of the group, and partly by direct observations of the bearing and dip of the strata.

The following Donations were presented to the Society since the last Meeting:—

Lexicon Syriacum Chrestomathiæ Kirschianæ denuo editæ accommodatum a Georgio Henrico Bernstein. Part 2.—*By the Author.*

Madras Journal of Literature and Science. Oct. and Dec. 1840. —*By the Madras Lit. Society.*

Letter to the Right Honourable the Chancellor of the Exchequer from J. E. D. Bethune, Esq. on Weights and Measures.— *By the Author.*

Address delivered at the Anniversary Meeting of the Geological Society of London, on the 19th of February 1841; and the announcement of the award of the Wollaston Medal and Donation Fund for the same year. By the Rev. Professor Buckland, D.D. &c.—*By the Author.*

The American Journal of Science and Arts, conducted by Professor Silliman, for January 1842.—*By the Editor.*

Mémoires de la Société Géologique de France. Tome 4, ptie. 2.— *By the Society.*

A Lecture on the employment of the Microscope in Medical Studies. By John Hughes Bennett, M.D.—*By the Author.*

Notes sur le Développement de Nerfs Particuliers à la surface du Cervelet. Par le Docteur Bennett.—*By the Author.*

Monday, 21*st March* 1842.

Dr ABERCROMBIE, V. P., in the Chair.

The following communications were read:—

1. On a New Species of British Grass of the genus Holcus, and Observations on some of the more closely allied species of Grasses found in the Neighbourhood of Edinburgh. By Richard Parnell, M.D., F.R.S.E.

This grass of the genus Holcus was stated to be new to the British Flora, since no mention of it is made in the works either of Sir James Smyth or Sir William Hooker; and as the author was unable

to find it noticed in the continental works, he proposed for it the name of *Biaristatus*, as illustrative of the species. Several specimens gathered in the neighbourhood of Edinburgh were exhibited, and the characters by which it differed from *Holcus mollis* and *Holcus lanatus* were pointed out.

Specific Characters.—Both florets awned ; sheaths of leaves smooth ; joints slightly hairy. (See Plate I.)

Description.—The *Holcus biaristatus* grows to the height of two feet or more, but more frequently of about eighteen inches. The root is perennial, fibrous, somewhat creeping. The stem round, smooth, and striated, bearing four or five leaves with smooth sheaths ; the upper sheath crowned with a prominent obtuse ligule. Joints five in number, furnished with a few delicate hairs with their points directed downwards. Leaves flat, broadish, acute, of a light green with whitish rough margins, both surfaces soft and slightly roughish to the touch. *Inflorescence* mostly simple panicled. *Panicle* erect, the rachis and branches hairy. *Spikelets* pendulous, rather large and few. *Calyx* of two glumes nearly of equal lengths, membranous, acute, hairy at the keels ; lower glume the smaller ; upper glume with a prominent green rib on each side. *Florets* two, both awned, of two paleæ, the outer palea of the lowermost floret about the same length as the small glume, pedunculated, of a lanceolate ovate form, smooth and glossy, with two delicate lines or ribs on each side ; keel slightly hairy towards the upper half, the base furnished with a few slender white hairs ; the upper or inner palea membranous, about equal in length to the outer palea, and minutely fringed at the margins. The upper floret sometimes wanting, but when present of about the same size and appearance as the one below, and elevated on a smooth peduncle about one-third the length of the floret. *Awn* rough, arising from a little beneath the apex of the outer palea, about equal in length to the palea, mostly straight, and projecting conspicuously beyond the calyx.

Holcus biaristatus differs from *Holcus mollis* and *Holcus lanatus* in the following respects :—In *Holcus mollis* (see Plate I.) the lowermost floret is of an ovate form, about half the length of the small glume, without a long dorsal awn or lateral ribs, whereas in *Holcus biaristatus* the lowermost floret is ovato lanceolate, about equal in length to the small glume, furnished with a long dorsal awn, and the sides with two lines or ribs.

In *Holcus lanatus* (see Plate II.) the lowermost floret has no dorsal awn, the uppermost floret with a short curved, smooth awn,

whereas in *Holcus biaristatus* the lowermost floret has a long dorsal awn, and the uppermost floret has a long straight rough awn.

An unusual variety of *Holcus mollis* was at the same time exhibited, differing only in the spikelets being much smaller and the panicle more compact (see Plate II.). Dr Parnell concluded the paper by making a few remarks on some of the more closely allied species of grasses. Fig. 1, spikelet; fig. 2, florets; fig. 3, glumes.

2. On the Ultimate Secreting Structure of Animals. By John Goodsir, Esq. Communicated by Professor Syme.

After referring to the labours of those anatomists who had verified Malpighi's doctrine of the follicular nature of gland ducts, the author alluded to Purkinje's hypothesis of the secreting function of the nucleated corpuscules of these organs. In a rapid sketch of the results of inquiries since the appearance of Müller's work "De Penitiore Structura Glandularum," and more particularly of the observations of Henle and others on the closed vesicles which are situated at the extremities of certain ducts, Mr Goodsir stated, that no anatomist had hitherto "proved that secretion takes place within the primitive nucleated cell itself, or had pointed out the intimate nature of the changes which go on in a secreting organ during the performance of its function."

Numerous examples were now given of secretions detected in the cavities of nucleated cells of various glands and secreting surfaces. Among these secretions were the ink of the Cephalopoda, and the purple of *Janthina* and *Aplysia*, bile in an extensive series of animals, urine in the mollusk, milk, &c.

The wall is believed by the author to be the part of the cell engaged in the process of secretion. The cavity contains the secreted substance, and the nucleus is the reproductive organ of the cell. A primitive cell engaged in secretion is denominated by the author a primary secreting cell; and each cell of this kind is endowed with its own peculiar property according to the organ in which it is situated. The discovery of the secreting agency of the primitive cell does not remove the principal mystery in which the function has always been involved; but the general fact that the primitive cell is the ultimate secreting structure is of great value in physiology, inasmuch as it connects secretion with growth as phenomena regulated by the same laws; and explains one of the greatest difficulties in the

science, viz., why a secretion flows from a free surface only of a secreting membrane,—*the secretion exists only on the free surface enclosed in the ripe cells which constitute that surface.*

The author then proceeded to the consideration of the origin, the development, and the disappearance of the primary secreting cell—a subject which necessarily involved the description of the various minute arrangements of glands and other secreting organs. After describing the changes which occur in the testicle of *Squalus cornubicus* when the organ is in a state of functional activity, and in the liver of *Carcinus mænas*, it was stated that these were selected as examples of two orders of glands denominated by the author vesicular and follicular.

The changes which occur in the first order consist in the formation and disappearance of closed vesicles or acini.

Each acinus might be, first, a single cell, denominated by the author the primary or *germinal* cell; or, secondly, of two or more cells enclosed in the primary cell, and produced from its nucleus.

The enclosed cells he denominates the secondary cells of the acinus, and in the cavities of these, between their nuclei and cell-walls, the peculiar secretion of the gland is contained. The primary cell with its included group of cells, each full of secretion, is appended to the extremity or side of one of the terminal ducts, and consequently does not communicate with that duct, a diaphragm formed by a portion of the primary cell-wall stretching across the pedicle. When the secretion in the group of included cells is fully elaborated, the diaphragm dissolves or gives way, the cells burst, and the secretion flows along the ducts, the acinus disappearing and making room for a neighbouring acinus, which has in the mean time been advancing in a similar manner. The whole parenchyma of glands of this order is thus, according to these observations, in a constant state of change,—of development, maturity, and atrophy,—this series of changes being directly proportional to the profuseness of the secretion.

In the second order of glands, the follicular, as exemplified in the liver of *Carcinus mænas*, the germinal cell or spot, is situated at the blind extremity of the follicle, and the secreting cells, as they advance along the follicle, become distended with their peculiar secretion.

Among other general conclusions deducible from these observations, it appeared that ducts are to be considered as intercellular passages, into which the secretions formed by cells are cast.

Finally, the author inferred from the whole inquiry, 1. That secretion is a function of the nucleated cell, and takes place within it; and, 2. That growth and secretion are identical—the same process under different circumstances.

The following gentlemen were duly elected Ordinary Fellows of the Society:—James Millar, Esq. F.R.C. Surg.; Sir James Forrest, Bart. Lord Provost of Edinburgh; James Stark, M.D., F.R.C. Phys.; John Adie, Esq. Optician.

Monday, 4th April 1842.

Sir T. M. BRISBANE, Bart., President, in the Chair.

1. On the Theoretical Investigation of the Absolute Intensity of Interfering Light. By Professor Kelland.

This Memoir is the prosecution of a subject on which the author had previously touched in a paper which is printed in the seventh volume of the Transactions of the Cambridge Philosophical Society. It has for its object the investigation of the quantity of light which is received on a screen of unlimited dimensions, after passing through a certain aperture, or suffering reflexion at two mirrors. The end for which the investigation is undertaken is to ascertain the *constant* which must be introduced in using Huygens's principle. From the fact, that each vibration at the aperture is multiplied by an area, on finding the effect on the screen, it is evidently requisite that a divisor of two dimensions is required to render the vibration at a point on the screen, similarly expressed with that at the aperture. According to the author's investigation, it appears that the divisor is the product of the length of a wave, and the perpendicular distance between the screen and the aperture. Hence, in reference to such questions, the enunciation of Huygens's principle is as follows:—

The vibration, at a given point, caused by a given wave, is found by taking the front of the wave, dividing it into an indefinite number of small parts, considering the agitation of each of these parts as the origin of a wave whose maximum of vibration, on reaching the point, is equal to the quotient of that at the disturbing point, divided by the product of the length of the wave, and the perpendicular from the disturbed point on the front of the wave.

2. On the Quarantine-Classification of Substances, with a View to the Prevention of Plague. By John Davy, M.D., F.R.S., L. & E.

In this paper, the author, after having noticed the ordinary quarantine classification of substances, into susceptible, non-susceptible, and doubtful, states as the result of his inquiries conducted in Turkey and the Mediterranean, that the distinctions involved in this arrangement have been made in a very unsatisfactory manner, not after careful research and deliberation, but rather during a period of panic, and hastily, in comparatively remote and ignorant times, and by men, for the then state of knowledge, ill qualified for the task, even had they entered upon it with all the calmness and caution that the subject required.

He next enumerates the principal substances constituting the three different classes, and then comments on each of them. His remarks tend to shew that the class of so-called non-susceptible articles, as glass, wood, metal, pottery, &c., since they have not any power of destroying, repelling, or preventing the adhesion of animal matter, ought rather to be considered as susceptible of conveying the matter of plague, in the same way that they are capable of conveying vaccine lymph, *i. e.*, if dried, or in tubes from which air is included; on the contrary, that the substances arranged in the class of so-called susceptible articles, as cotton, wool, fur, feathers, &c., articles abounding in atmospheric air,—the great promoter of the decomposition of putrescible animal matter,—are least entitled to be held fit to preserve and convey the matter of contagion, an inference confirmed by what is known relative to the preservation of animal matter generally, and especially vaccine lymph, and further confirmed by accumulated inference in lazarettos; according to which it would appear that there is no well authenticated instance on record of plague having been produced within the walls of a lazaretto, amongst those persons whose duty it is to examine and expose to the air the so-called susceptible articles imported from the Levant, and especially cotton and silk. In commenting on the subject, the author takes for granted that plague is propagated by a fixed matter of contagion, according to the commonly received views of the contagionists, as it is only on this ground that the quarantine system itself can be supported, or any discussion of the question of the classification of substances be called for. He points out, at the

same time, that, preliminary to a searching investigation into the qualities of substances for the practical purposes of quarantine, certain points of the first importance, at present unsettled, ought to be determined *in limine*,—as whether the plague be truly contagious or merely an epidemic disease; whether it is even endemic, independent of contagion; and whether, if arising from local circumstances, it is capable of becoming contagious. He remarks how the quarantine system has been unfortunately established on a basis of suppositions rather than on well ascertained facts, and how, consequently, it is held by all those who have given it their careful attention, to be, as a sanatary system, most unsatisfactory, troublesome, expensive, and insecure. He concludes with the expression of the hope that the time is not far distant when a thorough inquiry into the subject will be demanded preliminary to a revision of the quarantine laws, should the results of that inquiry be that plague is a contagious disease, or capable of becoming so. In the form of an appendix, he relates some particular instances in illustration of his remarks on the quarantine classification of substances, shewing how the distinctions are acted on practically, and how they tend to vitiate the present system of quarantine, supposing it to be otherwise perfect.

3. Results of Experiments on the Specific Heat of Certain Rocks. By M. Regnault of Paris. Communicated by the Secretary.

Professor Forbes observed that, in his communication to the Royal Society on the Conductivity of Soils for Heat, on the 20th December last (see Proceedings, page 343*), he had referred to the separation of the conductivity and specific heat, which are involved in the results of the thermometric experiments on subterranean temperature. In order to eliminate the effect of specific heat, M. Regnault of Paris (well known by his experiments on this subject) undertook, at the request of M. Elie de Beaumont, to ascertain the specific heats of the soils in which the different sets of thermometers are sunk. These are communicated in a letter from M. E. de Beaumont to Professor Forbes, as follows:

	Specific Heat.
Porphyry of the Calton Hill, ...	0.20654
Another experiment, ...	0.20587
Mean, ...	0.20620

	Specific Heat.
Sand of the Experimental Garden, ...	0.19432
Sandstone of Craigleith Quarry, ...	0.19257
Another experiment, ...	0.19152
Mean, ...	0.19205

Some correction would no doubt require to be made for the quantity of moisture contained in the rocks.

4. On the Effect of Snow in apparently increasing the Force of Solar Radiation. By Professor Forbes.

Referring to a communication made by him to the Society on the 1st February 1841 (see Proceedings, page 322), the author reminded the Society that he had then endeavoured to account for certain anomalous facts observed by Dr Richardson, connected with solar radiation in the Polar Regions, by adverting to the intense radiating effect of a covering of snow. The disappearance of this snowy covering in the month of May, the author had observed to be synchronous with the anomalous diminution of solar radiation, ascertained by a blackened thermometer, in the months of June and July, compared with the months of April and May.

Professor Forbes endeavoured to verify his conjecture, by direct experiments on the force of the sun amongst the snowy mountains of Switzerland; and it was so completely borne out, that the limited range of his instrument (Leslie's photometer) was in clear weather always outrun, when it was exposed on a snowy surface; and even when placed upon a dark rock (on the moraine of a glacier), the reflected light from the neighbouring snowy summits was so intense as to give extraordinarily high indications. Owing to the construction of the instruments, he was unable to estimate their readings correctly; but he hopes to make more accurate observations during the ensuing summer. Sir John Herschel's actinometer gave a value of the solar radiation nearly independent of its position upon snow or rock.

The following Donations were presented to the Society since the last Meeting:—

Annuaire de l'Observatoire Royal de Bruxelles. Par A. Quetelet, Directeur de cet Etablissement. 1842.—*By the Author.*

Nouveaux Catalogue des Principales Apparitions d'Etoiles Filantes. Par A. Quetelet.—*By the Author.*

Annuaire de l'Académie Royale des Sciences et Belles Lettres de Bruxelles. Pour l'An. 1842.

Bulletin de l'Académie Royale des Sciences et Belles Lettres de Bruxelles. 1841, Nos. 7–12; et 1842, Nos. 1, 2.—*By the Academy.*

Magnetische und Meteorologische Beobachtungen zu Prag. Herausgegeben von Karl Kriel. Erster Jahrgang.—*By the Author.*

Philosophical Transactions of the Royal Society of London, for the Year 1841. Part 2.—*By the Society.*

Examination Papers of the University of London for 1841.—*By the University.*

Plausible Reasons and Positive Proofs, shewing that no portion of the Devonian System can be of the age of the Old Redstone. By the Rev. D. Williams, A.M., F.G.S.—*By the Author.*

The Reminiscences of an Old Traveller throughout different parts of Europe. By Thomas Brown, Esq.—*By the Author.*

Monday, April 18, 1842.

The Right Hon. Lord GREENOCK, V.P., in the Chair.

The following communications were read:

1. On the Structure, Formation, and Movement of Glaciers; and the probable cause of their former extension and subsequent disappearance. By James Stark, M.D., F.R.S.E.

The author endeavoured to prove, from the recorded facts stated by different writers, that the crystalline particles of which the ice of glaciers is composed do not sensibly enlarge after being consolidated into compact ice; that the crystals have been shewn to be fully and perfectly formed in the course of a few nights in the Polar Regions; and that they have a position perpendicular to the layer of ice which they form,—their length being thus determined by the thickness of that layer.

The author next considered the different forms of stratification met with in glaciers, and stated that the greatest confusion prevailed on this point, different forms of stratification being confounded together. He therefore considered glaciers as composed of—

1. *Horizontal Strata*, or layers lying in the position in which they were first deposited, and only seen in the upper regions of the mountains. He stated that these strata were usually regarded as

marking the additions which the icy mass had annually received, each layer being the accumulated snow of one year; but that, as the Meteorological Tables kept at the Hospice of the Great St Bernard shewed that from 300 to 700 inches of snow fell during the six winter months, it seemed possible that each layer marked the separate storms of snow; or, if they marked the annual accumulations, they apparently proved, what had not previously been suspected, that snow and ice waste nearly as rapidly in the upper as they do in the lower regions.

2. *Vertical and Longitudinal Strata.* The author stated that these strata were always of great tenuity, were more or less perpendicular, but had always a direction parallel with the retaining wall or length of the glacier. Their mode of formation he attributed to the onward movement of the glacier leaving narrow spaces intervening between the sides of the already formed icy mass and the flanks of the valley, which, being filled up with the loose and softened snow lying on the sloping flanks, was, from the falling of the temperature during the night, and from contact with the already formed icy mass, converted into a layer of solid ice. From the thinness of these layers, the author regarded them as marking the additions which had been daily made to the glacier. The author also stated that it would, in all probability, be found that, wherever pillars, pyramids, or needles of ice were met with, this structure would be found present; as the fissures, which always crossed the glacier from side to side, divided it into transverse sections, which, when unequally supported below, would split into smaller fragments in the planes of their stratification, so that each fragment would necessarily assume the form of a vertical prismatic column.

3. *A combination of the Horizontal with the Vertical and Longitudinal Strata.* The author stated that, as the mass composed of the horizontal strata of the upper regions slowly advanced to the lower ones, it received, in the manner above stated, a lateral increase, which, at the same time that it increased its breadth, probably also added to its depth. That, as the glacier continued to advance, the horizontal strata, which lay uppermost, would melt away first, so that at one point they would only be observed in the middle of the glacier, and lower down even completely disappear. He mentioned several facts which seemed to prove his position.

4. *Transverse more or less inclined Strata.* The author stated

that this variety of stratification had not been recognized as a distinct form, but had been confounded with the horizontal stratification. He stated that this form would only be met with when the original structure of the glacier had been broken up and destroyed by some obstructing barrier or other cause. He instanced as the most marked example of this the terminal portion of the Rhone glacier, after it pours into the valley of the Rhone over its rocky barrier or precipice. He described the strata as being formed close to the icy mass on which the icy cataract descends, originally parallel to each other, and with a dip of 70° ; but that, as new layers are formed, and the first formed layers are pushed forwards, they lose their parallelism to each other, and assume angles of dip less and less as they approach the termination of the glacier. This change of dip and of parallelism the author attributed to the forward movement and plasticity of the mass, together with the greater amount of friction below, where the ends of the layers were in contact with the ground, and the constant deprivation of support anteriorly and below, from the continued melting of the ice at these parts, which would give the layers a constant tendency to fall forwards.

The author then proceeded to shew that fissures or crevices in glaciers could not be produced in consequence of the unequal expansion of the ice itself, nor in consequence of the expansion of the air contained within its pores ; but that in every case crevices were produced in censequence of the movement of the glacier over the inclined plane on which it rested.

The author next passed to the second division of his subject, the Movement of Glaciers, and first commented on the Dilatation Theory. He endeavoured to prove that none of the phenomena observed in glaciers could be accounted for by that theory. That a glacier was not retarded in its movement though riddled with crevices; that the supposed dilatation did not alter the form of the walls of these crevices; that it did not close them at their upper extremity nor widen them out below ; that it did not give rise to any convexity of the surface of the glacier ; that the icy mass did not require to touch the rocky walls of the valley through which it passed; that it could move onwards for miles quite unsupported on its margins ; that during a whole summer, whilst its movement was greatest, it never dilated even the few feet requisite to fill up the spaces intervening between its margin and the rocky walls of the valley ; that it advanced during the heat of the day, and during winter, when it is al-

lowed no dilatation can take place; that it was unlikely water could percolate during the course of one day through a solid mass of ice, more than 100 feet thick, especially when that ice was colder than the freezing point of water; that pools of water (in the Polar Regions) remained unfrozen for whole weeks during the summer whilst their progressive motion was greatest. For these and other reasons, the author arrived at the conclusion "that glaciers do not advance in consequence of a process of dilatation of their icy mass."

The author next enquired into the proofs of the truth of the sliding theory, and stated, that he had satisfied himself that every phenomenon known to occur in glaciers could be explained by it. He brought forwards, as explanatory circumstances, the descent of avalanches;—the descent of trees, along the slide of Alpnach;—the fact proved by the meteorological tables kept at the Hospice of the Great St Bernard, when compared with the descent of Hugi's hut on the Aar Glacier,—that the greater the fall of snow in the upper regions during winter, the greater is the descent of the glaciers during the following summer;—and lastly, the fact that the higher the mountain range (and of course the greater the quantity of ice or snow), the lower was the level to which glaciers descend. He also endeavoured to shew that the glaciers, or icy masses, covering the mountains, and filling their vallies, at no part of their course are frozen to the soil on which they rest; and that the temperature of the soil covered with deep masses of snow or ice, was probably never below 32° Fahrenheit.

The author made a short digression here, to account for the probable cause of the former extension of glaciers, and their subsequent disappearance. He endeavoured to shew, that the scattered boulders, &c. marking the former extension of glaciers, were all over the surface of the older alluvium (diluvium of Buckland) and he hence endeavoured to ascertain at what period that alluvium was formed. After a full examination of the subject, and especially from the examination of the fossil remains found in that alluvium, he arrived at the conclusion, that the waters of the deluge were the cause of the formation of that alluvium; and he accounted for the former extension of glaciers, by the known effect of water, in the act of evaporating, producing cold, especially when acted on by a brisk wind, which was the state of the earth immediately after the deluge. The increased moisture in the atmosphere at this period, he thought, would furnish ample supplies of snow and ice

for the purpose, and being first deposited on the elevated peaks, would rapidly spread over all those extended surfaces which glaciers are thought once to have covered. Their subsequent disappearance he accounted for, by supposing that the icy or snowy covering prevented the loss by radiation of the heat received by the earth's crust from the interior of the earth; since this heat, gradually accumulating below, would in time melt the icy masses at their lower extremities faster than they could be supplied from above, and thus reduce them to their present dimensions. He illustrated this view, by mentioning the fact, that the angular boulders, &c. are pretty equally scattered over all the extended surfaces which glaciers are thought formerly to have covered, but are rarely seen to form the dykes or moraines seen at the terminations of glaciers at present in existence; this fact apparently proving that they must have commenced their decay very shortly after their formation.

The author stated several other arguments in favour of the truth of the sliding theory; from all which he inferred, that the movement was not a continuous, but an interrupted process;—that when the melting of the sides of the mass detached it from its attachment to the sides of the valley, and it became undermined below, by the melting of its base, the force of gravity, unresisted by friction, was brought into play, and it made a sudden progressive movement (which might be only an inch or several feet), when it remained at rest, till the same causes produced a renewal of the same result. He shewed, that though many parts of these icy masses were nearly level, all the upper portions, and many of the lower, were lying over such inclined planes, that gravity could exert its full power in their propulsion; and as the whole icy mass was tolerably solid and continuous, the greater movement of one portion was communicated more or less throughout its whole length, and tended to urge forwards and downwards those parts which had less tendency to move onwards of themselves.

The author also endeavoured to account for the advance of one glacier, and the retirement of another along side of it, by supposing that it was caused by the snows being drifted away from the one valley exposed to the blast, and from which the glacier, which was retiring, descended, and being deposited in deep wreaths in the other, which was probably more sheltered, and from which descended the glacier, which was making destructive advances. The increased accumulation of snow, by furnishing a supply greater than the waste

caused the one glacier to advance, whilst the other retired, in consequence of the waste at its lower extremity exceeding the supplies from above.

2. On Plague, in relation to the question of its Nature, whether or not a Contagious Disease. By John Davy, M.D., F.R.S.S. L. & E.

The author, after adverting to the methods of investigating the subject, generally and specially, and expressing preference for the latter method; and, after pointing out how desirable it is in inquiries of an obscure nature, to find out *instantiæ crucis*, brings forward and details some facts, which he considers as such, on the question of the contagion of plague.

In June 1841, when there was plague in Egypt, but not in Constantinople or its neighbourhood, which had been free from the disease three entire years, a ship from Alexandria arrived in the Bosphorus, having plague on board. Of the crew and passengers, 18 out of about 96 died during the voyage; and of the remainder, 9 out of 16 who were taken into the Lazaretto. Moreover, certain persons of Constantinople, employed in the duties of the Lazaretto, contracted the disease,—four altogether, of whom three died.

As the disease, with which they were attacked was the same as that imported, and as this was unquestionably plague, and was isolated in the Lazaretto, these instances seem to be demonstrative, that plague can be propagated by contagion, and that therefore (if there be, as it is presumed, a certain consistency and constancy in diseases) it must be considered a contagious disease, although, on many occasions, owing to obscure interfering causes, it may not spread from person to person, and become epidemic.

The author, till he visited the Levant and became acquainted with these cases, was sceptical as to the contagion of plague; and in consequence, before he allowed them to weigh on his mind as evidence, he examined into them most carefully, without being able to find any circumstance connected with them, tending even to raise suspicion of their accuracy as examples of communicated disease.

Among several points of collateral interest connected with these cases, he adverted only to one, viz. the manner in which the disease may have been communicated,—thereon expressing his opinion or conjecture, that in one of the four, it owed its origin to actual con-

tact, and in the other three, to touching substances, which had shortly before been touched by the plague patients, such as glass, metals, or earthenware; and he assigned the reasons which led him to this conclusion.

3. Analysis of Two New Minerals of the Zeolite Family. By Thomas Anderson, M.D. Communicated by Dr Christison.

The minerals in question are the Phakolite of the Bohemian Mittelgebirge, and Caporcianite, a newly discovered mineral, first observed by Dr Savi, in a copper-mine at Caporciani, in the valley of Cæcino. The author found, that in point of composition, Caporcianite belongs to that division of the zeolites, which comprehend Analcine, Ledererite, Potash-harmotome, Chabasie, and Levyn, and whose constitution is represented by the mineralogical formula $r\,S^2+3\,AS^2+z\,A\,q$,—z being a variable quantity, r representing the variable monatomic bases, and A & S alumina and silica. The formula for Caporcianite proved to be $r\,S^2+3\,A\,S^2+3\,A\,q$, and the monatomic base consists chiefly of lime. Phakolite belongs to that groupe of zeolites comprising Gigantolite, Harringtonite, Mesotype, Lehuntite, Mezolite, Scolezite, Pyrargillite, and Antrimolite, whose composition is represented by the mineralogical formula $r\,S^3+x\,A\,S+z\,A\,q$,—the equivalents of alumina and silica being variable, as well as water; and the formula for Phakolite is $r\,S^3+2\,A\,S+3\,A\,q$, the monatomic basis being lime, potash, and soda. The numerical proportions of the constituents of the two minerals were as follows:—

	Caporcianite.		Phakolite.
Silica acid,	52.8	...	45.628
Alumina,	21.7	...	19.480
Peroxide of iron,	0.1	...	0.431
Lime,	11.3	...	13.304
Magnesia,	0.4	...	0.143
Potassa,	1.1	...	1.314
Soda,	0.2	...	1.684
Water,	13.1	...	17.976
	100.7	...	99.960

4. Dr Christison exhibited specimens from the Government Superintendent of Tea Culture in Assam, illustrating

the several ages at which the leaves of the Assam and China Tea-plants are used for making the different commercial varieties of black and green tea.

An examination of these specimens seemed to prove, that the leaves of the China tea-plant, cultivated at the same plantation with the tea-plant of Assam, are considerably less, and somewhat thicker, but otherwise so exactly similar, that the two plants may well be mere varieties of the same species,—an opinion now generally adopted by botanists in India. The specimens further illustrated the doctrine deduced from recent investigations in India, that the different kinds of green and black tea are made from the leaves of one species of plant, collected at different periods of their development. The specimens were collected in April 1841. The unexpanded shoots and very young leaves are marked as yielding Pekoe, a black tea, and Young Hyson, a green tea, by different modes of preparation. The fully-expanded, but still young leaves, are stated to produce Pouchong, Souchong, and Campoi, among the black teas, and Imperial, Gunpowder, and Hyson, among the green teas. Older and firmer leaves produce Congo, a black tea, and Twangkay and Hyson-skins, two of the green teas; and the oldest and coarsest of the leaves produce Bohea, the lowest in quality of the black teas.

The following Donations were presented to the Society since the last Meeting:—

Proceedings of the Royal Society. No. 52.—*By the Society.*

Theoretical Investigations on the Motions of Glaciers. By W. Hopkins, F.R.S.—*By the Author.*

Comptes Rendus Hebdomadaires des Séances de l' Académie des Sciences. Tome xiv. Nos. 8–12 —*By the Academy.*

Journal of the Asiatic Society of Bengal. 1841. No. 116.—*By the Society.*

Elements of Agricultural Chemistry and Geology. By James F. W. Johnston, F.R.S.—*By the Author.*

PLATE I

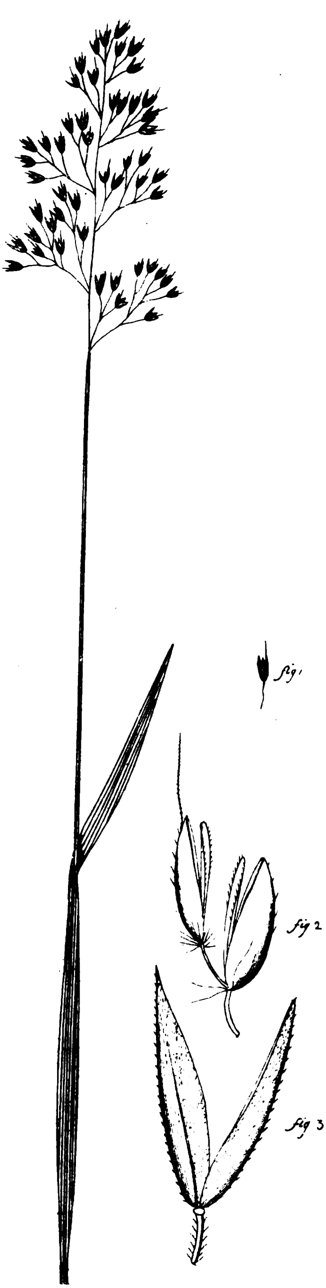
Holcus [redacted] *biaristatus*.

Holcus mollis

...rnell M.D. delt et sculpt

Printed by J.G...

PLATE II



Holcus mollis
(Variety)

Holcus lanatus

. Parnell M.D. delt et sculpt.

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

1842–43. No. 21.

Monday, 5th December 1842.

Sir T. MAKDOUGALL BRISBANE, Bart., President, in the Chair.

The following communications were read:—

1. On the Construction of a New Music Hall. By Sir George S. Mackenzie, Bart.

The author noticed a variety of facts which were in direct opposition to the common notions entertained on the subject; and which led to the conclusion, that the chief object to be kept in view, was to destroy all sound that did not go directly from the source of sound to the ears of the audience, by preventing reflection. He described the plan of the Hall now building at the Assembly Rooms, the form of which is crucial, owing to the space on which it stands having been limited, and the necessity for connecting it with the pre-existing apartments; and he stated that he would have preferred a square, with the orchestra somewhat retired on one side. The new Hall was to be regarded as an experiment; and if one mode for destroying superfluous sound did not succeed, others would be tried.

2. On the Geology of Roxburghshire. Part 1. By David Milne, Esq. *See Proceedings on 9th January* 1843.

The following Donations of Books to the Society's Library were announced as having been received since the closing Meeting of last Session.

Report of the Eleventh Meeting of the British Association for the Advancement of Science, held at Plymouth in July 1841.—*By the Association.*

Nieuwe Verhandelingen van het Bataafsch Genootschap der proefondervindelijke Wijsbegeerte te Rotterdam. Vol. viii. St. 2.—*By the Society.*

Archives du Museum d'Histoire Naturelle Publiées par les Professeurs-Administrateurs de cet Etablissement. Tome i. Livr^{ns} 2, 3, 4, et Tome ii. Livr^{ns} 1, 2.—*By the Editors.*

A new Analogy for determining the distances of the Planets from the Sun, and of the Satellites from their Primaries.—*By the Author.*

The American Journal of Science and Arts, conducted by Professor Silliman, for April, July, and October.—*By the Editor.*

Scheikundige Onderzoekingen, gedaan in het Laboratorium der Utretchtsche Hoogeschool. Stuks 1, 2, 3.—*By the Editors.*

Proceedings of the London Electrical Society. Session 1841–42. Parts 3, 4, 5.—*By the Society.*

Voyage dans la Russie Méridionale et la Crimée. Planches, Livr^{n} viii. Par M. Anatole Demidoff.—*By the Author.*

Astronomische Nachrichten. Nos. 433–446.—*By Professor Schumacher.*

Observations Météorologiques faites a Nijne-Taguilsk (Monts Oural), Governement de Perm. 1841.—*By the Author.*

Novorum Actorum Academiæ Caesareæ Leopoldino-Carolinæ Naturæ Curiosorum Voluminis Undevicesimi Supplementum Alterum.—*By the Academy.*

The Quarterly Journal of Agriculture, and the Prize Essays and Transactions of the Highland and Agricultural Society of Scotland. June, September, and December.—*By the Society.*

Journal of the Statistical Society of London. Vol. V. Parts 1, 2, 3.—*By the Society.*

An Exposition of the Nature, Force, Action, and other properties of Gravitation on the Planets.—*By the Author.*

Tijdschrift voor Natuurlijke Geschiedenis en Physiologie. Uitgegeven door J. Vander Hoeven, M.D., en W. H. Vriese, M.D. Deel viii. St. 4; and Deel ix. St. 1.—*By the Editors.*

The Transactions of the Linnean Society of London. Vol. XIX. Part 1.

The Proceedings of the Linnean Society of London. Nos. 13, 14. —*By the Society.*

Ordnance Survey of the County of Kilkenny in Ireland. 49 sheets. —*By His Excellency the Lord Lieutenant.*

Bulletin de la Société Impériale des Naturalistes de Moscow. 1842. Nos. 1, 2.—*By the Society.*

Memoirs of the Literary and Philosophical Society of Manchester. (Second Series), Vol. VI.—*By the Society.*

Journal of the Asiatic Society of Bengal. Nos. 115, 118, 119, 120, and 121.—*By the Society.*

Six Lectures on Arithmetic, containing a familiar explanation of the principles and rationale of the General Rules of Arithmetic.— *By the Author.*

Transactions of the American Philosophical Society held at Philadelphia, for promoting useful knowledge. Vol. VIII. Part 1.

Proceedings of the American Philosophical Society. Nos. 20, 21, and 22.—*By the Society.*

The Ninth Annual Report of the Royal Cornwall Polytechnic Society. 1841.—*By the Society.*

Ueber das Magnetische Observatorium der Koniglich-Sternwarte bei Munchen, von Dr J. Lamont.—*By the Author.*

Die Galvanographie, eine methode, gemalte Tuschbilder durch galvanische Kupferplatten im Drucke zu Vervielfältigen, von Franz von Kobell.—*By the Author.*

Proceedings of the Royal Society. No. 53.

Philosophical Transactions of the Royal Society of London for the year 1842. Part 1.—*By the Royal Society.*

Astronomical, Magnetical, and Meteorological Observations made at the Royal Observatory, Greenwich, in the year 1840, under the direction of George Biddell Airy, Esq., Astronomer Royal. —*By the Royal Society.*

Proceedings of the Geological Society of London. Nos. 77 to 87. —*By the Society.*

Teoremi sulle Sezioni Coniche dimonstrati da Nicola Trudi. Nos. 5, 6, 7.—*By the Author.*

Seconde Mémoire sur les Kaolins ou Argiles a porcelaine. Par MM. Alexandre Brongniart et Malaguti.—*By the Authors.*

Forty-ninth Report of the Literary and Philosophical Society of Newcastle-upon-Tyne.—*By the Society.*

Flora Batava. Nos. 123 and 124.—*By the King of Holland.*

Notice respecting the Fossils of the Mountain Limestone of Ireland, as compared with those of Great Britain, and also with the Devonian System. By Richard Griffith, F.R.S.E., &c. &c.—*By the Author.*

Mémoires de l'Académie des Sciences de l'Institut de France. Tome xviii.

Mémoires Présentés par divers Savants à l'Académie Royale des Sciences de l'Institut de France. Tome vii.—*By the Royal Academy.*

Ueber die Abhaengigkeit der Physischen Populationskraefte von den einfachsten Grundstoffen der Natur mit specieller Anwendung auf die Bevolkerungs-Statistik von Belgien, von Dr Ferdinand Gobbi.—*By the Author.*

Mémoires de la Société de Physique et d'Histoire Naturelle de Génève. Tome ix. p^{tie} 2.—*By the Society.*

Journal of the Royal Asiatic Society of Great Britain and Ireland. No. 13.—*By the Society.*

Magnetische und Meteorologische Beobachtungen zu Prag, von Karl Kriel. (Zwieter Jahrgang.)—*By the Author.*

1st and 2d Bulletins of the Proceedings of the National Institution for the promotion of Science at Washington.—*By the Institution.*

Researches in Physical Geology. By W. Hopkins, Esq. Parts 1, 2, 3. —*By the Author.*

On the Errors of Chronometers, and Explanation of a new construction of the Compensation Balance. By E. J. Dent, Esq.—*By the Author.*

Twenty-second Report of the Council of the Leeds Philosophical and Literary Society, 1841–42.—*By the Society.*

Transactions of the Royal Cornwall Polytechnic Society, 1842. No. 1.—*By the Society.*

System der Krystalle, ein Versuch von M. L. Frankenheim, Professor an der Universitat von Breslau.—*By the Author.*

Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin, 1840.

Bericht über die zur Bekanntmachung geeigneten Verhandlungen der Kongl. Preuss. Akademie der Wissenschaften zu Berlin. Juli 1841 bis Juni 1842.—*By the Academy.*

Liber Cartarum Prioratus Sancti Andree in Scotia e Registro ipso in Archivis Baronum de Panmure hodie asservato. (Printed for the Bannatyne Club.)—*By O. Tyndall Bruce, Esq.*

The Grasses of Scotland. By Richard Parnell, M.D., F.R.S.E.—*By the Author.*

The Second Supplement, completing the Seventh Edition of Dr Turner's Chemistry. By Justus Liebig, M.D., and William Gregory, M.D.—*By the Editors.*

Transactions of the Society instituted at London for the Encouragement of Arts, Manufactures, and Commerce. Vol. LII. Pt. 2. —*By the Society.*

Journal of the Royal Geographical Society of London. Vol. XI. Pt. 2.—*By the Society.*

Abhandlungen der Mathematisch-Physikalischen Classe der Koeniglich Bayerischen Akademie der Wissenschaften. Band iii. Abth. ii.—*By the Academy.*

Prodromus zu einer neuen verbesserten Darstellungsweise der Hohern Analytichen Dynamik, vom Grafen Georg von Buquoy. 1 Lieferung.—*By the Author.*

Proceedings of the Zoological Society of London. Nos. 93 to 108. *By the Society.*

Transactions of the Royal Institute of British Architects. Vol. I. Pt. 2.—*By the Institute.*

Historical Transactions of the Royal Society of Copenhagen. 6 vols. —*By the Society.*

Pilote Français comprenant les Côtes Septentrionales de France depuis Barfleur jusqu'a Dunkerque. Publié par ordre du Roi. Partie 5me.—*Par le Department de la Marine.*

Ueber das farbige Licht der Doppelsterne und eineger anderer Gestirne des Himmels, von Christian Doppler.—*By the Author.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Tome xiv. Nos. 13–26, et Tome xv. Nos. 1–8.—*By the Academy.*

Donations of extensive collections of valuable specimens in Mineralogy and Conchology to the Society's Museum, by Lord Greenock and Mr Stark, were also announced ; and the thanks of the Society were returned to the Donors by the President, viz. :—

1. A number of Mineral and Fossil Organic Specimens, from various localities.—*Presented by Lord Greenock.*
2. Specimens of Land and Fresh-water Shells, chiefly from the neighbourhood of Edinburgh.
3. Specimens of Marine Shells, chiefly from the Firth of Forth. And,
4. Specimens of Zoophytes, chiefly from the Firth of Forth.—*Presented by John Stark, Esq.*

John Goodsir, Esq., Conservator of the Museum of the Royal College of Surgeons of Edinburgh, proposed by Professor Syme, was duly elected an Ordinary Fellow.

Monday, 19*th December* 1842.

The Right Honourable Lord GREENOCK, Vice-President, in the Chair.

The following communications were read:—

1. Letter on Terrestrial Magnetism, addressed to the Secretary. By Professor Hansteen of Christiania.

CHRISTIANIA, *the 22nd April* 1842.

* * * * I HAVE the pleasure to send you two papers: the first on the changes, which the moment of a magnetical needle or bar undergoes as a function of the elapsed time, and of the variations of the temperature; the second, in the German language, is an extract of a letter to Professor Kupffer of St Petersburg, exhibiting the changes of the time of 300 horizontal vibrations, in Christiania, of my invariable magnetical cylinder, made by Dollond in 1819, from 1820 to 1839. In the Latin Programma, page 17, seven later observations, to this year, are annexed. In the first paper it is demonstrated by experiments, with nine different magnetical cylinders, that the moment M is a function of the time t, elapsed after its being magnetized, of the following form:—

$$M = C + B e^{-qt},$$

where $C = M_{\infty}$ is the value of M, when $t = \infty$, e the basis of the natural logarithms, q a constant depending of the quality and hardness of the steel, $B = M_0 - M_{\infty}$ is the whole variation of M between $t = 0$, and $t = \infty$. The moment of every magnetical needle has accordingly a limit C, which it cannot transgress; and every variable needle may be used to determine the intensity in a voyage, when only the three constants, B, C, q, are determined by three observations, including the whole time of the voyage. In page 13, you will find under No. 4, the history of the cylinder belonging to the "Hansteen Apparatus" of the Royal Society of Edinburgh, from November 5. 1821, to October 29. 1826. After its arrival at Edinburgh, it seems to have lost some more of its power, perhaps from coming into a higher temperature. For, according to my calculations, it should already have been

almost invariable after 664 days. I shall only remark, that to such delicate researches as the variation of the moment of a magnetical needle, which is nearly constant, a single observation is not sufficient, as the daily regular and irregular variations may make 2″ to 3″, upon a time of 800″.

The variation of the time T of 300 vibrations, page 17, seems to point out a variation of the horizontal intensity, either periodical (of short period), or undulatory; for, as the time T has been without variation, or even decreased from 1820, 71, to 1823, 54, in the first period, where, according to the formula $M = C + B\,e^{-qt}$, the decrease of M should have been greatest, the change of T may have its origin from a variation in the horizontal intensity of the terrestrial magnetism. It had a maximum in 1823, a minimum in 1828, or 1829, and another maximum in 1839. I have found the same difference between 1823 and 1827, by different other cylinders, and in different places, as Copenhagen, Altona, and Paris; also, the same difference between 1832 and 1839 in Göttingen, with the same cylinder. In the letter to Mr Kupffer, I sought to express this variation as a function of the longitude of the moon's ascending node; and, accordingly, the period should be 18⅔ years: the time to come will decide.

I have for four years observed the meteorological instruments here in Christiania, at five fixed hours, 7 — 9 forenoon, and 2 — 4 — 10 afternoon; in the last year are added 0^h and 7^h afternoon. From these observations I have calculated the constants a_1, a_2, α_1, α_2, μ in the formula,

$$\beta = \mu + \alpha_1 \sin(a_1 + t) + \alpha_2 \sin(a_2 + 2t),$$

where β is the variable height of the barometer, t the horary angle of the sun, μ the mean value of β in 24 hours for the whole month. These constants are calculated, and curves constructed, for every month in the year. By these constants I have found, that here, in Christiania, lat. 59° 54′ 42″.5, the barometer has two maxima and two minima in the nine months; but that in the three months, May, June, and July, when the sun is not six hours below the horizon, the nocturnal minimum vanishes, and the morning and evening maximum coincide in the night. In the winter months, November, December, January, when the day is only six hours, the oscillation in the afternoon is very little, so that it is evident, that, in greater latitudes, near the polar circle, the minimum in the afternoon will vanish, and the two maxima, morning and evening, will coincide in the afternoon. This apparent anomaly is, of course, a necessary consequence of the general rule, modified by the short day. I have in the same manner calculated ten years' observations in Dresden, by Inspector Lohrmann, six times per day, 0^h, 3^h, 6^h, 9^h, 18^h, 21^h. In Dresden, the two minima are visible through all the twelve months. I have sent the calculations and the curves to Mr Schumacher, in Altona, and hope he will publish them in his "Astron. Nachrichten." The whole oscillation, between the greatest maximum and lowest minimum in Christiania, is greater than that deduced from the observations of Mr Sommer at Königsberg. The mean temperature at Christiania is less than that stated by L. von Buch, that is, scarce more than 4¼° Reaumur.

In 1839 I made a voyage through Denmark and the northern parts of Germany, and observed the following horizontal intensities, expressed in absolute unities after the method of Gauss (unities of longitude = 1 millim.,

of weight 1 milligramme, of time = 1 second mean time). The observations are made with my standard cylinder D (*De mutationibus momenti*, page 16, 17) and are reduced to absolute quantity by the method, *ibid.*, page 40, by the constant logarithm, log. A, which, in the calculations, is assumed = 6,00811, instead of 6,00843.

Christiania, . . .	1839, April,	1.5470	Altona, Schumacher's garden, .	1839, Sept.	1.7085
... . . .	... June,	1.5485	Bremen, ...	1839, July,	1.7172
... . . .	... Oct.	1.5422	Hanover, ...	1839, Sept.	1.7490
... . . .	1841, April,	1.5464	Magdeburg, . . .	1839, Aug.	1.7662
Götheborg, . . .	1839, Sept.	1.5728	Leipzig, ...	1839, Aug.	1.8092
Copenhagen, . . .	... July,	1.6503	Dresden, ...	1839, Ang.	1.8252
... . . .	1840, ...	1.6517	Gotha, ...	1839, Aug.	1.8057
Kiel, ...	1839, Sept.	1.6819	Eisenach, ...	1839, Aug.	1.7973
Bramstedt, ...	... ...	1.6857	Cassel, ...	1839, Aug.	1.7834
Altona, Kessel's garden, ...	... July,	1.7120	Göttingen, . . .	1839, Aug.	1.7751*

Taking the horizontal intensity H, in absolute unities for Göttingen = 1.7751, and according to your observations, Göttingen = 0.9783, Dresden = 1.0007, Edinburgh = 0.838 (Paris = 1.000), I find for Edinburgh in absolute unities, from the observations—

In Göttingen H = 1.5205,

In Dresden H = 1.5284. Mean 1.5244.5,

a little less than in Christiania. When T is the corrected time of 100 vibs. of the Edinburgh cylinder, No. 1, and $HT^2 = A$, I find, supposing in Edinburgh T = 270″578.

$$\log. A = 5.04769.$$

As the horizontal intensity has so many variations, hourly, daily, monthly, regular and irregular, and undulatory, or perhaps periodical variations in 18–19 years, I find the comparison with Paris, especially when it is founded upon a single observation, made in different hours of the day, and after an interval of a month or more, not perfectly sure.† I will illustrate this by the following corrected observations of 300 vibrations of my cylinder D here in Christiania, in the garden of the Observatory.

1841, April 16,	4 31′, P. M.	811″.93	1841, Sept. 1,	6ʰ 6′, ...	810″.65
... ... 22,	0 56, ...	812.74	... ...	7 38, ...	811.61
... ... 30,	8 5, ...	810.68	 15,	10 12, A. M.	811.63
... May 9,	7 8, ...	810.44	... ...	10 35, ...	811.80
... ... 23,	2 22, ...	811.02	... Oct. 8,	9 57, ...	812.62
... June 17,	6 43, ...	810.07			

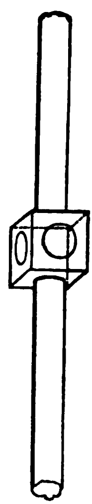
The greatest difference between 1841, June 17, 6^h 43′ P. M., and 1842, Feb. 26, 10^h 32′ A. M., is 3″; and between 1841, June 17, and 1842, April 10, 5_h 29′ P. M. = 5″.17, under influence of aurora borealis.

* The 30th July 1834, Hofrath Gauss observed the same cylinder in the same place in the garden of the Observatory, and found reduced time, T, of 300 vibrations = 759″.29, which gives intensity = 1.7672.

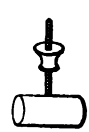
† [The value of the horizontal intensity at Edinburgh compared with Paris (.840) was not deduced, as Professor Hansteen supposes, from a single comparison. It was repeated by me in two different years with almost perfect agreement, and confirmed by observations at Brussels, a station independently compared with Paris. Professor Bache of Philadelphia has since found the same relative intensity for Edinburgh agreeing to the 3d decimal place.—J. D. F.]

			h	′		″	
1842,	Feb.	17,	0	5,	P. M.	812.14	
...	...	20,	5	21,	...	811.40	
...	...	22,	11	31,	A. M.	812.27	
...	...	...	4	31,	P. M.	811.85	
...	...	26,	8	36,	A. M.	812.27	The minimum of intensity here occurred at 10h 32′; the maximum later in the afternoon, after the last observation at 1h 41′ P. M. This day was a magnetical term, and the results of the vibration of the needle were in good harmony with the corresponding observations on the bifilar magnetometer.
...	...	...	8	56,	...	812.18	
...	...	...	9	15,	...	812.36	
...	...	...	10	14,	...	812.60	
...	...	...	10	32,	...	813.06	
...	...	...	10	51,	...	812.57	
...	...	...	11	10,	...	812.72	
...	...	...	11	30,	...	812.38	
...	...	...	1	3,	P. M.	811.97	
...	...	...	1	22,	...	812.24	
...	...	...	1	41,	...	811.91	
...	March	13,	5	44,	...	811.67	
...	...	20,	5	1,	...	811.97	
...	...	21,	5	0,	...	812.25	
...	...	25,	6	6,	...	811.35	
...	...	29,	6	48,	...	811.38	
...	April	10,	5	29,	...	815.24	Aurora Borealis.
...	...	...	6	0,	...	813,17	
...	...	11,	10	11,	A. M.	812.69	

In Göttingen I made 96 observations between 8 A. M. and 4½ P. M., from Aug. 27 to Sept. 10. In Dresden only 4, between Aug. 15 and 20; two A. M. and two P. M. When it is possible I generally in every place make at least two observations, one between 10 and 11 A. M., and the other between 4 and 6 P. M., in order to eliminate the daily variation.



Since 1819, I have very often observed the *dip* here in Christiania, with three different instruments, *1st*, A 5-inch instrument by *Dollond*, divided to 20′, with two needles; the one cylindrical, with conical ends, and in the middle a cube, which is perforated in two directions, so that the axis can be inserted from four different sides, and turned round *ad libitum;* the other flat lancet-formed, in which the axis can be put in from two sides, and turned. *2d*, A 6-inch instrument by *Ertel*, in Münich, divided to 10′, with a flat needle and three axes, which can be turned round *ad libitum*. *3d*, An 8-inch instrument by *Gambey*, in Paris, with three needles and fixed axes. By the instrument *1st* and *2d*, after every complete observation, the limb east and west, and the needle in the four usual situations, the dip read of four times in every position, after having been lifted from the agate planes (in all thirty-two readings), the axis was turned 90°, and a second observation made. This was continued four times, till the axis arrived in its former position. In all three instruments the needle very often was brought out of equilibrium, by the application of a little tube, with a screw perpendicular to its axis, upon the axis of the needle. This is useful, in order to diminish the influence of the form of the pivots, especially on needles with fixed axis; and the influence of magnetical particles in the circle; shortly, to diminish constant errors. After this proëmium, I shall communicate my observations and their results.



	Year. t.	n.	d	Observed, i.	Calculated.	Δ
	1819,857	9	2′.915	72° 39′.00	72° 41′.62	− 2′.62
	1820,397	9	1.410	... 43.63	... 39.67	+ 3.96
	1820,496	9	1.892	... 44.90	... 39.31	+ 5.59
	1820,678	9	1.212	... 42.70	... 38.72	+ 3.98
	1820,823	8	2.059	... 48.05	... 38.15	+ 9.90
	1821,159	7	3.587	... 47.80	... 36.96	+ 10.84
Dollond,	1821,226	7	2.873	... 37.60	... 36.72	+ 0.88
	1821,303	7	3.517	... 42.90	... 36.45	+ 6.45
	1822,262	7	1.809	... 33.30	... 33.16	+ 0.14
	1822,548	6	3.757	... 33.80	... 32.19	+ 1.61
	1823,373	8	2.503	... 16.80	... 29.47	− 12.67
	1825,144	8	2.828	... 21.80	... 23.87	− 2.07
	1825,155	8	2.741	... 21.60	... 23.83	− 2.23
Ertel,	1828,325	10	2.325	... 16.20	... 14.69	+ 1.51
	1830,497	5	1.757	... 6.50	... 9.08	− 2.58
	1830,877	8	0.753	... 7.16	... 8.15	− 0.99
	1831,251	7	0.508	... 8.71	... 7.26	+ 0.45
	1832,521	4	0.414	... 0.56	... 4.33	− 3.77
Gambey,	1838,405	7	1.042	71 57.58	71 53.14	+ 4.44
	1839,828	14	0.851	... 53.54	... 51.02	+ 2.52
	1841,304	3	2.732	... 45.36	... 49.05	− 3.69
	1841,769	7	0.888	... 51.66	... 48.49	+ 3.17
	1842,179	12	0.806	... 46.60	... 47.63	− 1.03

t is the mean time of the observations in every group; n the number of complete observations in every mean; d the probable error of every mean; i the mean dip of the n observations. As the dip i in a not too long interval of time $t - t_0$ may be expressed by the following formula,—

$$i = a + b\,(t - t_0) + c\,(t - t_0)^2$$

where a, b, and c are constants, I have taken $t_0 = 1820$, and by the method of least squares found

$$a = 72^\circ\ 41'.1 \pm 1'.935$$
$$b = -3'.63978 \pm 0'.21654$$
$$c = +\ 0'.056166 \pm 0'.008749;$$

and from these constants calculated the dip in the 5th column. Δ is the difference between observation and formula. The instrument of Dollond was too little, but the great number of observations (102 in 5.3 years), and the great variety of methods which have been employed, I suppose may have destroyed all constant errors. Since better instruments were employed, the quantity of Δ is much less; and I think that all these differences are not really errors of observation, as it is evident that the dip has its irregular variations as well as all other magnetic phenomena of the earth. The formula—

$$i = 72^\circ\ 41'.1 - 3'.63978\,(t - 1820) + 0'.056166\,(t - 1820)^2$$

with the probable errors of a, b, and c, gives

Minimum in Christiania $= 71^\circ\ 42'.2 \pm 11'.718$
when $t = 1852.4 \pm 5.4$ years.

I have found, that the dip in Paris, observed between 1798 and 1836, may be represented by the following formula:—

$$i = 69^\circ\ 38'.9 - 4'.465\,(t - 1800) + 0'.023395\,(t - 1800)^2,$$

which gives the minimum $i = 66^\circ\ 5'.8$ when $t = 1895$.

That the dip cannot decrease to zero, and, accordingly, should have a minimum, is quite probable; by these two series of observations, this minimum is likely to arrive before the end of this century, perhaps earlier in northern than in southern latitudes.

I am not quite of your opinion, that the observations with a dipping needle should be rejected *only* while it gives a difference of a degree and a half between the different positions. This difference may be derived from two different causes,—the *eccentrical position* of the *centre of gravity*, and the *deviation* of the *form* of the *pivots* from a *true cylinder*. In the first case the mean will approximate very nearly to the true dip, if the moment of the needle before and after the reversion of the poles is not too different; and when the needle is magnetized with the same four magnets, and the same number of strokes, this will scarcely arrive. In the second case, the needle will give *different errors* by *different dips*. This error can be detected by turning the axis in the needle in different observations in the same place, or by applying an eccentrical weight upon the axis, if it is fixed. When the moment of this weight is varied in the different observations, the needle will repose upon different points of the pivots in different observations, and thereby the error will be diminished, if not quite eliminated. I think this has been the case with your needle A.1, as the difference A.2 — A.1 changes its sign by diminished dip.

	A.1.	A.2.	A.2 — A.1.
	° ′	° ′	′
Edinburgh, ...	71 57.8	71 55.1	— 2.7
Greenwich, ...	69 12.4	69 11.5	— 0.9
Brussels, ...	68 36.4	68 28.5	— 7.9
Berlin, ...	68 1.9	68 5.5	+ 3.6
Bonn, ...	67 49.1	67 51.3	+ 2.2
Göttingen, ...	67 47.0	67 53.5	+ 6.5
Carlsbad, ...	66 36.0	66 47.5	+ 11.5
Wien, ...	64 41.2	64 51.0	+ 9.8

It is also my opinion, that even the best needle may, by a single observation, give an error of three to five minutes (perhaps more), including error of observation, and irregular variation of the direction of magnetical force of the earth. I shall here offer some observations with Gambey's instrument here in Christiania, in 1839.

Time of Observation.	Needle.	n.	Marked end, N. P.		Marked end, S. P.		Dip.	
			a.	*b*.	*c*.	*d*.		
Sept. 30, 5½ P.M.	II.	24	72° 0′.9	73° 11′.6	72° 0′.5	70° 2′.7	71° 48′.9	After these three observations I better equilibrated both needles upon a stone the 2d October.
Oct. 1, 0½ P.M.	III.	32	70 27.3	70 33.2	73 18.6	73 24.0	71 55.8	
... ... 2 P.M.	II.	32	72 8.55	73 8.1	71 58.3	70 23.3	71 54.6	
... 3, 10 A.M.	III.	32	71 56.7	71 46.8	71 54.2	72 0.8	71 58.2	*Aurora Bor.* 8½ P.M.
... ... 10¾ A.M.	II.	32	71 53.1	71 58.6	71 55.45	71 13.9	71 45.26	
... 13, 2 P.M.	III.	32	71 59.9	71 40.8	71 42.1	71 50.6	71 48.3	Strong *A. B.* the 12th, 9¾ P.M. behind the clouds.
... 27, 2 P.M.	III.	31	71 47.3	72 1.4	72 21.7	72 1.1	72 2.9	
Nov. 7, 10 A.M.	I.	34	72 50.65	69 57.05	71 21.0	73 13.5	71 50.55	
... 17, 1¼ P.M.	III.	32	87 51.3	58 22.5	58 11.7	88 6.7	71 54.7	Eccentric *weight* upon the axis.
... 18, 11¾ A.M.	III.	32	58 3.6	87 59.0	87 47.5	58 30.5	71 52.2	Weight turned round the axis 180°.
... 19, 1½ P.M.	II.	32	58 51.8	87 50.2	88 36.5	57 28.5	71 56.9	Weight.
... ... 2½ P.M.	II.	32	88 6.8	58 42.6	58 9.4	87 37.6	71 57.3	Weight turned round 180°.
... 20, 11 A.M.	I.	32	96 58.4	51 51.7	54 6.8	94 7.2	71 49.2	Weight (this needle has a weaker magnet.)
... 21, 2½ P.M.	I.	34	53 55.0	92 47.3	92 24.1	56 9.3	71 54.7	Weight turned.
						Mean,	71 53.54	

n is the number of readings in each series; *a* the dip, when the marked side of the needle turned to east, four readings with limb east, and four when west; *b* the dip, when the marked side was west, and limb both east and west; *c* and *d* the same, after changing the poles. When the weight was applied, the dip is calculated by the formula—

$$\text{tang}\, i = \frac{\text{cotang}\, a + \text{cotang}\, d - \text{cotang}\, b - \text{cotang}\, c}{\text{cotang}\, a \,.\, \text{cotang}\, d - \text{cotang}\, b \,.\, \text{cotang}\, c};$$

and by this method the different magnetical moment of the needle, before and after the returning of the poles, is quite eliminated. The eight first observations, without weight, give 71° 53′.1, the last six, with weight, 71° 54′.2, and the probable error of the mean of the whole series is 0′.851. Though the probable error of the three determinations 1839, 823 (14 obs.), 1841, 769 (7 obs.), 1842, 179 (12 obs.), are only 0′.851, 0′.888, and 0′.806, their deviations from the formula are respectively + 2′.52, + 3′.17, and — 1′.03, which, I think, may principally be ascribed to irregular variations in the dip.

I beg your pardon for my profusion in this matter, but my long experience with different instruments of this kind has made me somewhat sceptical in the way of observing the dip, and I am not content before I have varied the methods of observation, and multiplied the observations as much as possible.

In observing the intensity by vibrations of a magnetical cylinder, you are almost the only observer who has not neglected one or more of the necessary reductions, as that for temperature, rate of the chronometer, force of torsion, arc, and to observe the cylinder in the same place before and after

the voyage. Some have neglected them all, and thereby brought the method in an undeserved miscredit.

If you should desire any other communications which are in my power to procure you, I shall make them with great pleasure. I am, Sir, with the greatest respect, your obedient and humble Servant,

CHR. HANSTEEN.

To Professor FORBES.

2. Notice of the occurrence in Scotland of the *Tetrao medius*, shewing that supposed species to be a hybrid. By James Wilson, Esq.

There exists in several northern continental countries a peculiar kind of grouse, called by foreign naturalists *Tetrao medius*, on account of its exhibiting, as it were, a combination of the characters of the wood-grouse or capercailzie on the one hand, and of the black-cock on the other. It is never found except in countries inhabited by the two species last named; and as it presents a union of their characters, several naturalists have inferred that it is not itself a distinct kind, but a hybrid, resulting from the casual intercourse of the other two. But most naturalists have maintained that it is a distinct species, chiefly upon the principle, that, in the wild state, birds of different species do not intermingle sexually with each other. Mr Wilson, however, having discovered that, in certain districts of Scotland into which Lord Breadalbane has lately introduced the capercailzie, and in which the black-cock previously existed in abundance, this so-called intermediate grouse has also now made its appearance, he draws the conclusion, that it is not a distinct species, but a hybrid or mule. "It had not been previously known in Scotland, at least in our times,—it has not been introduced by any one from abroad,—and yet here we now find it in the very districts inhabited by the other two." Mr Wilson exhibited a specimen recently killed on the estate of Dunira, and shewed its entire agreement with the foreign *T. medius*, by comparing it with a specimen from Norway.

3. On the Coloration of the Blood. By the late Daniel Ellis, Esq., F.R.S.E. Communicated by Dr Christison.

[*Note.*—During the latter part of his life, Mr Ellis had been engaged in drawing up a statement of his views with regard to the function of respiration in animals generally; and having, for some years previous to his death, had it in contemplation

to lay before the Royal Society an account of that part of his researches which relates to the cause of the change of colour of the blood in its passage through the lungs, he had prepared and nearly completed the paper on this subject, of which the following is a short abstract. It may be proper to state that no reference is made in the paper to the recent experiments of Magnus, which are now generally held to afford incontrovertible proof of the existence of free carbonic acid in greater, and of oxygen in less quantity, in venous than in arterial blood. These experiments came to be known in this country only a short time before Mr Ellis's death, and, had he been acquainted with them, might have tended to modify his views.]

In the first part of the paper, the author states that he still maintains the opinion expressed in his published work on respiration, viz., that the quantity of carbonic acid formed in respiration is exactly equal to that of the oxygen consumed; and he enters into a detailed critical analysis of the different experiments recorded by authors on this subject, placing, however, his chief reliance upon those of Berthollet, and of Allen and Pepys, in order to justify his opinion. He also holds the view that the exhalation of carbonic acid and consumption of oxygen are not independent processes, but are the immediate result of the direct union of carbonic and oxygen within the air-cells of the lungs, and he expresses doubts as to the accuracy of the experiments of Edwards, which have by many been held to establish the opposite view.

Proceeding upon this basis, the author next examines the effects of air and other re-agents upon blood out of the body, and deduces the conclusion, that, although oxygen gas appears to have the direct effect of changing the colour of the blood from dark to bright red, that change may be induced without the presence of any oxygen gas, and that within the living body, it is not necessary to attribute the change to the agency of that gas. In proof of this, the author refers particularly to the experiments of Stevens and of Gregory, and he also details experiments made by himself, which shew that, while a strong saline fluid has of itself the power of changing the colour of the blood, weaker saline solutions, or such as contain no more salt than is naturally dissolved in the serum of the blood, do not effect any change unless oxygen gas be also present; and that water, which contains dissolved in it less than $\frac{1}{160}$ part of its weight of salt, does not brighten blood even in air.

The author forms the conclusion, that we must seek some other cause of the coloration of the blood than the direct action of oxygen. That cause he conceives to be of the nature of electricity. He refers to various experiments which shew that electricity produces the effect of reddening the blood, and he explains the development of electricity in respiration, by supposing that the heat evolved by the combination of carbon with oxygen in the lungs, becoming latent, is converted into electricity, and there produces its effect on the colouring matter of the blood. That effect the author holds to consist in the decomposition of the saline ingredients of the serum, the consequent separation of a quantity of free alkali, which, acting on the hematosine, changes its colour from dark to bright red.

The following Donations of Books to the Society's Library were announced.

Astronomical Observations made with Ramsden's Zenith Sector, together with a Catalogue of the Stars which have been observed, and the amplitudes of the Celestial Arcs, deduced from the observations at the different stations. Published by order of the Board of Ordnance.—*By the Master-General, &c.*

Proceedings of the London Electrical Society. Part 6. Session 1842-43.—*By the Society.*

Bulletin de l'Académie Royale des Sciences et Belles Lettres de Bruxelles. 1842. Nos. 3-9.

Nouveaux Mémoires de l'Académie Royale des Sciences et Belles Lettres de Bruxelles. Tome xv.

Annales de l'Observatoire Royal de Bruxelles. Publiées par le Directeur, A. Quetelet. Tome ii.—*By the Royal Academy.*

Annuaire Magnétique et Météorologique du Corps des Ingénieurs des Mines de Russie ou Recueil d'Observations Magnétiques et Météorologiques faites dans l'étendue de l'Empire de Russie. Par A. T. Kupffer. Annee 1840.—*Par l'Administration Imperiale des Mines.*

Astronomische Nachrichten. Nos. 447-461.—*By Professor Schumacher.*

Transactions of the Philosophical Society of Cambridge. Vol. VII. Part 3.—*By the Society.*

Scheikundige Onderzoekingen, gedaan in het Laboratorium der Uttretchtsche Hoogeschool. Stuk. 4.—*By the Editors.*

Donations to Museum—

Specimens illustrative of Mr Stark's paper on the Food of the Herring and Salmon.—*Presented by John Stark, Esq.*

Specimens of the Woods of Ceylon (fifty different kinds.)—*Presented by J. Anstruther, Esq.*

Specimens of Minerals and Fossil Organic Remains from Malta, the Ionian Islands, and Ceylon.—*Presented by Dr John Davy.*

Geological Specimens from the Velay and Vivarais (Haute Loire and Ardêche.)—*Presented by Professor Forbes.*

Monday, 9th January 1843.

Dr ABERCROMBIE, Vice-President, in the Chair.

The following communications were read:—

1. On the Growth of the Salmon. By Mr Andrew Young, Invershin, Sutherlandshire. Communicated by James Wilson, Esq.

Mr Young has here taken up the subject of the salmon's growth where it was necessarily left off by Mr Shaw. So far as the earliest or fresh-water state of the fish is concerned, he entirely agrees with the observer just named. He then states the various opinions which prevail regarding the more or less rapid growth of smolts and grilse, and shews by tabular lists (the result of frequently repeated experiments), that the increase in their dimensions is extraordinary so soon as they descend into the salt water. So far back as the months of April and May 1837, he marked a number of descending smolts, by making a peculiar perforation in the caudal fin, by means of small nipping irons constructed for the purpose. He re-captured a considerable number of them ascending the rivers as grilse, in the course of the ensuing months of June and July, and weighing several pounds each, more or less according to the difference in the length of their sojourn in the sea. Again, in April and May of 1842, he marked a number of descending smolts, by clipping off the little adipose fin upon the back. In June and July he caught several of them returning up the river, and bearing his peculiar mark,—the adipose fin being absent. Two of these specimens were exhibited to the Society. One marked in April, and re-captured on the 25th of July, weighed 7 lbs.; the other, marked in May and re-captured on the 30th July, weighed 3¼ lbs. As the season advances

grilse increase in size, those being the largest which abide the longest in the sea. They spawn in the rivers after their first ascent, and before they have become adult salmon.

Mr Young also described various experiments instituted with the view of shewing the transition of grilse into salmon. He marked many small grilse after they had spawned in winter, and were about to re-descend into the sea. He re-captured them in the course of the ensuing summer as finely-formed salmon, ranging in weight from 9 to 14 lbs., the difference still depending on the length of their sojourn in the sea. He has tried these experiments for many seasons, but never twice with the same mark. A specimen marked as a grilse of 4 lbs. in January 1842, and re-captured as a salmon of 9 lbs. in July, was exhibited to the Society. It bore a peculiarly twisted piece of *copper* wire in the upper lobe of the caudal fin. Those marked and retaken in 1841 were marked with *brass* wire in the dorsal fin. With these and other precautions Mr Young avoided the possibility of any mistake as to the lapse of time. Both grilse and salmon return uniformly to their native streams; at least it very rarely happens that a fish bearing a particular mark is found except in the river where it was so marked. Salmon in the perfect state as to form and aspect, also increase rapidly in their dimensions on again reaching the sea. A spawned salmon weighing 12 lbs. was marked on the 4th of March, and was re-captured on its return from the sea on the 10th of July, weighing 18 lbs. Mr Young is of opinion that salmon rather diminish than increase in size during their sojourn in rivers; and he illustrates this and other points of his subject by numerous experiments and observations.

2. On the Geology of Roxburghshire. Part 2. By David Milne, Esq.

Mr Milne divided his paper into two parts, the first comprehending a description of the leading geological features of the district; the second containing the inferences of a cosmological character, which the facts related in the first part seemed to warrant.

In describing the geology of Roxburghshire, Mr Milne referred, *first*, to the stratified rocks; *secondly*, to the igneous rocks; and, *thirdly*, to the superficial, or (as they have been sometimes termed) the diluvial deposits.

The stratified rocks were stated to consist of the following series, beginning with the oldest, viz.—greywacke, old red sandstone, and the coal measures. As to the long disputed question regarding the

existence of the new-red-sandstone formation in this county, Mr Milne, whilst not wishing to affirm absolutely the non-existence of any strata whatever belonging to this epoch, referred to the older formation the great mass of the red sandstones abounding in the district, adding that he had himself seen none which necessarily belonged to a later epoch.

It was stated that no fossils had been found in the greywacke strata, but that in the old red sandstone formation, scales and bones of the *Holoptichius* had been found embedded both in the red and the white coloured strata.

The igneous rocks consist of all the varieties of felspars, basalts and greenstones, known in other parts of Scotland, the first mentioned of these being the oldest. All these rocks occur in the form of dykes, as well as hills, of which the Eildons and Cheviots are the highest and most extensive.

The superficial deposits consist, beginning with the oldest, of the boulder clay, well known in the Lothians,—of sand and gravels,—and of great blocks or rounded fragments of rocks, all strewed over the surface. It was mentioned, that, whilst the boulder clay was deposited in tumultuous waters (presenting no signs of stratification), the sands and gravels being for the most part stratified, have been deposited by waters not in violent action. The greater number of boulders in Liddesdale consist of grey granite, very similar to that of Criffel, situated between thirty and forty miles to the westward.

In part 2d, the author observed, that the greywacke formation, presenting as they do enormous foldings, in consequence of which the formation is traversed by ridges and valleys, all running east and west by compass, must have been acted on here, as throughout the rest of this part of the island, by a force or system of forces, which acted in a particular direction; and that as hardly any igneous rocks whatever occur, within the limits of this formation, it seemed that the greywacke strata had not been elevated and folded together by igneous action, but more probably in consequence of changes in the form of the Earth's nucleus, as suggested by Elie de Beaumont.

The elevation of the greywacke ranges was followed by eruptions of felspathic and a few greenstone rocks, which took place chiefly on the outskirts of that formation; and from the sediment afforded by the wearing down of these rocks, still at the bottom of a sea, the stratified rocks surrounding and partly covering these older rocks were formed. As the heaviest sediment would be deposited first, the sandstones filled with oxide of iron, and now constituting the principal beds of the old red sandstone formation, would girdle the hills of greywacke and older felspathic rocks, whilst the strata of white sandstone, shales,

and limestones, being composed of lighter sediment, would be carried farther, and become members of the coal measures situated in Liddesdale, Northumberland, and Berwickshire.

The formation of the whinstone dykes, one of which was described as running in a NW. direction, for about twenty-four miles, was ascribed by the author to the irruption of igneous matter into fissures previously formed in the earth's crust.

The beds of gravel and sand, as well as the boulders, the author thought might all be explained on the supposition, that the district had been covered by the waters of the ocean, when they were deposited. He adduced facts and arguments for the purpose of shewing that certainly none of these deposits could have been formed by glacial action, and that probably submarine currents, or great waves, such as are known to have been produced by submarine eruptions, would be sufficient to account for all the phenomena.

3. On the Property of Transmitting Light, possessed by Charcoal and Plumbago, in fine plates and particles. By John Davy, M.D., &c.

The charcoal of the pith of the elder consists of plates of extraordinary thinness. It was in examining this charcoal, that the author first observed the property which is the subject of his paper. He detected it by means of the microscope, using a high magnifying power. By analogy, he was led to infer that the power of transmitting light must belong to charcoal in general, in all its varieties, when reduced to the state of fine powder or filaments,—an influence which he found confirmed by experiment in a number of different instances, as the charcoal of the pith of the sycamore, of the pith of the rush, the fibre of cotton, flax, &c. He also found it to belong to lamp-black, to cork in very fine powder, to anthracite, and plumbago.

The light transmitted he found to vary in its hues, from almost white, as in the instance of the thinnest plates of the charcoal of the pith of the elder, to brown and red of various shades, in the instances of lamp-black, anthracite, and plumbago.

He considers the property of translucency belonging to charcoal and plumbago, in their finely divided state, as favourable to the opinion now commonly received, that these substances and diamond owe their marked peculiarities not to difference of chemical mixture, but of mechanical structure. Incidentally, he notices the specific gravities of these substances,—stating, as the result of his own experiments, that the specific gravity of charcoal, cork, and anthracite, is about 1.5; and that of plumbago about the same, making allow-

ance for the ferruginous and earthy matter with which the carbon in this mineral is mixed.

In conclusion, he offers the conjecture, that the coloured tints of vapour and fluids in which carbon is suspended, may be connected with the translucency of this substance, and that other bodies, hitherto considered opaque, may be found capable of transmitting light, when examined in a manner similar to that which he has employed.

The following Donations of Books to the Society's Library were announced.

Maps of the Ordnance Survey of England and Wales. Nos. 80, 81, and 90.—*By the Master-General of the Ordnance.*

Maps of the Irish Ordnance Survey, containing the County of Clare. 77 sheets.—*By His Excellency the Lord-Lieutenant.*

Report made at the Annual Visitation of the Armagh Observatory. By the Rev. T. R. Robinson, D.D.—*By the Governors of the Observatory.*

Proceedings of the American Philosophical Society. Vol. II. No. 23.—*By the Society.*

Journal of the Asiatic Society of Bengal. Nos. 122 and 123.—*By the Society.*

Donations to Museum—

Specimens of Fossil Organic Remains from East Kilbride and neighbourhood, Lanarkshire. Collected by the late Rev. David Ure, A.M.; and a number of them figured in his "History of Rutherglen and East Kilbride."—*Presented by John Stark, Esq.*

Tail of a Wild Elephant from Ceylon.—*Presented by Rob. Bryson, Esq.*

Specimens of Fossil Fishes from Syria.—*Presented by Dr John Davy.*

Monday, 23d January.

The Very Reverend Principal LEE, Vice-President, in the Chair.

The following communications were read:—

1. Chemical Observations on the Flowers of the Camellia Japonica, Magnolia grandiflora, and Chrysanthemum

Leucanthemum; and on three proximate principles which they contain. Part I. By Dr Hope.

The Abstract of this Paper has been postponed till the remaining part of it shall be communicated.

2. On the Law of Visible Position in Single and Binocular Vision, and on the Representation of Solid Figures by the union of two dissimilar plane figures on the Retinæ. By Sir David Brewster, K.H. Part I.

The Abstract of this Paper also has been postponed till the whole shall have been read before the Society.

The following Donations of Books to the Society's Library were announced.

Proceedings of the London Electrical Society. Part 7.—*By the Society.*

De Fide Uranometriæ Bayeri Dissertatio Academica. Scripsit D. F. G. A. Argelander.—*By the Author.*

Memoirs of the Royal Astronomical Society. Vol. XII.—*By the Society.*

Philosophical Transactions of the Royal Society of London. 1842. Part ii.—*By the Society.*

Kongl. Vetenskaps-Academiens Handlingar, för Aren 1839-40.

Arsberättelse om framstegen i Fysik och Kemi Afgiven den 31 Mars 1839 and 31 Mars 1840. Af Jac. Berzelius.

Ärsberättelse om Technologiens Framsteg, Afgiven den 31 Mars 1839 and 31 Mars 1840. Af G. E. Pasch.

Arsberattelser om nyare Zoologiska Arbeten och Upptackter. Afgifne för Aren 1837-40. Af C. J. Sundewall.—*By the Royal Swedish Academy.*

Donation to Museum—

Three Specimens of Salmon, shewing the rapid growth (on descending to the sea) of the Smolt to the state of Grilse, and of the latter to the adult condition.—*By Mr Andrew Young, Sutherlandshire.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

1843. No. 22.

Monday, 6th February 1843.

Sir T. MAKDOUGALL BRISBANE, Bart., President, in the Chair.

The following communications were read :—

1. On the Law of Visible Position in Single and Binocular Vision, and on the representation of Solid Figures by the Union of dissimilar Plane Pictures on the Retina. By Sir David Brewster, K.H.,—*concluded.*

This subject is treated under eight different heads :—1. On the law of visible direction in *Monocular* vision. 2. On the law of visible direction in *Binocular* vision. 3. On vision of objects of three dimensions, by monocular vision; by binocular vision. 4. On the binocular vision of figures of different magnitudes. 5. On the cause of the perception of objects in relief by the coalescence of dissimilar pictures. 6. On the doctrine of corresponding points. 7. On the vision of cameos and intaglios. 8. On the change in the apparent position of the drawings of solid bodies.

The general object of this paper is to establish the law of visible direction, (position in monocular vision,) and to shew that it is equally applicable to binocular vision, and affords a complete explanation of various phenomena which had been considered incompatible with

it, but for which no theory had been proposed. In the last two sections, the author treats of the collateral subject of the vision of cameos, and of the drawings of solid bodies.

2. Papers on Glaciers. No. 1, Account of a Geometrical Survey of the Mer de Glace of Chamouni. By Professor Forbes.

This paper does not admit of abridgment. The author gave an account of a survey which he executed of the whole extent of the principal glacier of Mont Blanc and its tributaries. A base line of nearly 3000 feet was carefully measured in the valley, and extended by means of a very careful triangulation to a point on the glacier distant 28,600 feet, and elevated 4400 above the base line. From the several points of this triangulation, the positions and heights of the adjoining mountains were taken and laid down on a map on a scale of $\frac{1}{25000}$ of nature, portions having been drawn out to $\frac{1}{10000}$. The map was laid before the Society, and is now being engraved.

The following Donations of Books to the Society's Library were announced.

Elements of Chemistry, including the Applications of the Science to the Arts. By Professor Graham, University College, London. Part 6.—*By the Author.*

Maps of the Irish Ordnance Survey, containing the County of Waterford, in 42 sheets.—*By his Excellency the Lord Lieutenant.*

The following Donations to the Museum were presented—

Specimens of Volcanic Rocks from Vesuvius, and Minerals from Derbyshire.—*Presented by Sir T. M. Brisbane, Bart.*

Specimens of Fossil Shells from Grignon, collected by Dr Stark in Oct. 1833.—*Presented by John Stark, Esq.*

The following gentlemen were duly elected Ordinary Fellows of the Society :—

Dr John Rose Cormack, Fellow of the College of Physicians of Edinburgh.

Dr Allen Thomson, Professor of the Institutes of Medicine in the University of Edinburgh.

Monday, 20th February 1843.

The Right Honourable Lord GREENOCK, Vice-President, in the Chair.

The following communications were read :—

1. On the Anatomy of the Human Placenta. By John Goodsir, Esq., Conservator of the Museum of the Royal College of Surgeons of Edinburgh.

In the first section of the paper, the author described the parts which enter into the structure of the villi of the placenta. The villi are covered by a membrane with which anatomists are already familiar. Within this membrane, and attached to its internal surface, is a layer of cells, which has also been observed, and described as epithelium. The cells composing this layer, Mr Goodsir denominated the external cells of the villus. The next structure is a membrane not hitherto described, and named by the author the internal membrane of the villus. The adhesion of this membrane to the external cells is so slight, that it is generally seen at some distance from them, even in villi which have undergone no violence. Within the internal membrane of the villus, a set of very transparent cells, hitherto undescribed, is situated. These the author denominated the internal cells of the villus. The ultimate loops of the umbilical capillaries are imbedded in this mass of cells, the cells and vessels being closely bound up by the internal membrane of the villus.

The second section of the paper was devoted to the description of the fœtal portion of the organ. Mr Goodsir described the development and structure of the tufts of the chorion. He stated that the development consists in the addition of cells to the extremity of each villus of the tuft, these being supplied by a germinating mass, which resembles the spongiole of the root-fibre of a plant. These tufts and villi are entirely cellular, and are covered by a fine membrane. Before the villi become vascular, the ovum derives nourishment from the decidua, by the absorbing agency of the cells of the spongioles at the extremities of the villi of its chorion. When bloodvessels have formed in the villi, the cells, although less numerous, still remain, and are believed by Mr Goodsir to be the active absorbing agents in the villi of the placenta. In the perfect placenta, the villi of the chorion appear as the internal membrane, and the internal cells described in the first part of the paper. These, along with the umbilical vessels, constitute the fœtal portion of the placenta.

In the third section of the paper, in which Mr Goodsir treated of the maternal portion of the organ, he corroborated the statements of of Professors Weber and Sharpey as to the nature and structure of the decidua; and he more particularly described an interfollicular tissue, consisting of cells, which conduces, he thinks, as much as the enlargement of the glands, to the thickening of the mucous membrane. Since the discovery made by Professors Weber and Sharpey, too little attention, he believed, has been directed to the secretions of the thickened mucous membrane. This secretion, which forms the greater part of the decidua reflexa, is, according to the author, composed entirely of cells, and is the nourishment destined for the embryo, being taken up after solution by the absorbent cells of the villi. By tracing the cavities of the vessels of the gravid uterus from without inwards, as had formerly been done by Professor Owen, the author verified the statements of certain anatomists, that the vessels pass from the uterus into the decidua, and open on the internal surface of the latter by oblique valvular orifices. He likewise observed, that the meshes enclosed by the uterine veins become smaller and more ribbon-shaped near the cavity of the placenta, and that in that cavity they represent the appearance of hollow threads, which pass in great numbers from the uterine surface of the organ on to the extremities and sides of the villi, and also from villus to villus. Along the cavities of these threads the cellular mass of the decidua becomes continuous with the external cells of the villi.

From these observations, Mr Goodsir concluded that the sac of the placenta is a network of enlarged decidual vessels, the meshes of which have been reduced to hollow threads; and, secondly, that not only is the external membrane of the villi a part of the mother, being a portion of the membrane of her vascular system, but that the external cells also are maternal, being decidual cells continuous, along the hollow threads, with the general mass of the decidua.

Mr Goodsir stated in conclusion—

1. That the external membrane and the external cells of the villi constitute together the central division of the placental decidua, or the principal maternal portion of the organ, the cells being secreting cells destined to separate from the blood of the mother a matter proper for the nourishment of the fœtus.

2. That the villi present, in addition, an internal membrane and internal cells, which together constituted, at an earlier period, the villi of the non vascular chorion; that the internal cells are absorb-

ing cells, like the chyle cells of the intestinal tube, taking up for the fœtus the matter secreted by the external cells.

3. That the placenta not only performs the function of a lung, but also that of a gastro-intestinal mucous membrane.

2. On the Mode in which Sound is produced and diffused, and on the Vibrations caused in the quality of Sound by substance and form. By Sir George S. Mackenzie, Bart.

The following Donations of Books to the Society's Library were announced.

Voyage dans la Russie Méridionale et la Crimée, par M. Anatole de Demidoff. Tome 4, avec un Atlas des Planches.—*By the Author*.

Bulletin de la Société Géologique de France, from 15th March to 9th September 1841.—*By the Society*.

Proceedings of the Glasgow Philosophical Society, 1841-42.—*By the Society*.

The following Gentlemen were duly elected Ordinary Fellows of the Society:—Joseph Mitchell, Esq., civil engineer; Duncan Davidson, Esq. of Tulloch.

Monday, 27th February 1843.

Dr ABERCROMBIE, Vice-President, in the Chair.

The following communication was read.

Papers on Glaciers. No. 2, describing the Rate of Motion of the Ice of the Mer de Glace, deduced from observation. By Professor Forbes.

The author detailed in this paper the methods of observation by which he was enabled to ascertain the *daily* and even *hourly* motion of different parts of the glacier.

The following are some of the principal results:—

I. In the particular case of the Mer de Glace, the motion of the higher parts of the glacier are on the whole slower than those of its lower portion, but the motion of the middle region is slower than either.

The following table, the result of observations at a series of ascending stations, will authorize this conclusion.

	Velocity.
Lower part,	1.000 / 0.770
Middle do.,	0.479
Higher do.,	0.674

II. The Glacier du Géant moves faster that the Glacier de Lechaud in the proportion of 7 to 6.

III. The centre of the glacier moves faster than the sides. When two glaciers unite, they act as a single one in this respect, just as two united rivers would do.

The author measured the velocities at different places in the breadth of the glacier, and it was found to increase towards the centre. The following are the numerical results, assuming the motion of the ice near the edge as the standard or the unit of reference.

Side.			Centre.
1.000	1.332	1.356	1.367

IV. The difference of motion of the centre and sides of the glacier varies (1) with the season of the year, and (2) at different parts of the length of the glacier.

1. From the observations made, the author concludes, that "the variation of velocity diminished as the season advanced; and that it was proportional to the absolute velocity of the glacier at the same time."

2. The variation of the velocity with the breadth of the glacier is least considerable in the higher parts of the glacier, or near its origin.

V. The motion of the glacier generally varies with the season of the year and the state of the thermometer.

Perhaps the most critical consideration of any for the various theories of glacier motion is the influence of external temperature upon the velocity. It is shewn in this paper, by a direct numerical comparison, and by projected curves, that in nearly every instance the velocity of the glacier, during any period of days, has a reference to the temperature of the same period. If the thermometer fell, the glacier advanced slower, and *vice versa*. It is not, however, to be inferred that at the same external temperature the velocity will always be the same; only at any season, the change will always be in the same *direction*, and governed by the thermometer, though not always the same in amount.

The author also deduced from various indirect considerations, that it is very improbable that the glacier *stands still* in winter. On the

contrary, he supposes that though its velocity is less than in summer, it still bears a considerable proportion to it.

Monday, 6th March, 1843.

The Right Honourable Lord GREENOCK, Vice-President, in the Chair.

The following communications were read :—

1. On the Nature, Locality, and Optical Phenomena of Muscæ Volitantes. By Sir D. Brewster, K.H.

2. On the Structure of the Lymphatic Glands. By John Goodsir, Esq., Conservator of the Museum of the Royal College of Surgeons of Edinburgh.

The author stated that the different lymphatics, as they enter the gland, become deprived of their external tunic, which passes on to the surface of the organ, to assist in forming its capsule. The middle tunic also becomes weaker, and presents the appearance of fibres arranged in the form of arches, which enclose rounded or oval spaces, particularly towards the surface of the gland, and at the angles formed by the anastomosis of one lymphatic with another. Mr Goodsir then observed that it was to the changes which the internal tunic of the lymphatics undergoes in the interior of the gland, that these organs owe their peculiar structure. This tunic, when traced from the afferent or efferent vessels into the gland, is found to become thicker and more opaque, till at length it no longer transmits light. It consists of two parts—a fine external membrane, and a granular substance attached to the inner surface of that membrane. The membrane belongs, according to the author, to the class of germinal membranes, with the germinal spots placed at regular distances. This germinal or primitive membrane of the internal tunic of the intra-glandular lymphatics is extremely delicate, and has germinal spots of an oval form, with compound nuclei. These spots are the sources of the nucleated particles which come from the granular substance. These particles are about the 4000th to the 5000th of an inch in diameter, and form a considerable proportion of the corpuscles, which have been long recognised in the fluid which may be squeezed out of lymphatic glands. The layer which these nucleated particles forms on the internal surface of the germinal membrane is so thick as almost to fill the cavity of the lymphatic. The canal of the vessel is irregularly pierced through the granular substance, the surface and particles of which are freely

bathed by the chyle or lymph. This granular layer being continuous in both directions with the scale-like epithelium of the extra-glandular lymphatics, it is therefore merely a developed form of this epithelium.

Mr Goodsir then stated that the opinion of those anatomists who hold that the intra-glandular lymphatics form a net-work, is correct. In the glands in which the meshes of this net-work are elongated, the vessels, even after forcible injection, never assume the cellular appearance. In those glands again, or in those parts of glands in which the meshes are rounded or equilateral, the injection of mercury produces the appearance of globular cells. In other lymphatic glands, a process of absorption, similar to that which occurs in the maternal vascular system of the human placenta, reduces the meshes of the lymphatic net-work to mere threads or bars, and converts one or more short lymphatic branches into one multilocular cavity. All these varieties are modifications of the simple net-work.

The ultimate capillaries of the blood-vessels form very fine net-works on the external surface of the germinal membrane of the intra-glandular lymphatics. The anatomical relations of this capillary net-work, and the germinal membrane and granular substance of these lymphatics, are identical with those of the vessels, membrane and secreting epithelia of true glands.

One of the functions of the granular substance, the author stated to be the secretion of chyle and lymph corpuscles; but, as these are also formed in other parts of the lymphatic system, he reserved his observations on this part of the subject for a future occasion. He concluded by observing, that the structure he had described afforded, in his opinion, satisfactory evidence, 1st, That the lymphatic glands are merely net-works of lymphatic vessels, deprived of all their tunics but the internal, the epithelium of which is highly developed for the performance of particular functions; and, 2d, That these peculiar lymphatics have a fine net-work of capillary blood-vessels in close contiguity with their external surfaces, for the purpose of affording matter for the continued renovation of the epithelium.

3. On the Determination of Heights by the Temperature of Boiling Water. By Professor Forbes.

The investigations in this paper were made in order to reduce certain observations on the boiling point of water, made by the author in the Alps, in 1842.

He considered that it has been too generally assumed that the boiling point corresponds to a barometric pressure which expresses the elasticity of steam taken from the usual tables. He, therefore, attempted to deduce the connection of these data by a direct comparison of cases, in which both the barometer and boiling point were noticed by himself. He finds this result, that the pressures increase *rigorously* in a geometrical ratio, whilst the temperature of the boiling point rises uniformly. This law is not new, for Deluc arrived at the same result; but it appears to have been considered by all late writers as unworthy of adoption, and the scale of the elasticities of vapour by Dalton or Ure has been preferred. Now, these elasticities cannot, it is well known, be accurately represented by a geometrical proportion to the temperature; but Professor Forbes finds that the geometrical ratio represents the barometric heights exactly, whilst the tabular elasticities do not. But, farther, since the common barometric formula shews that the pressure varies geometrically, whilst the height above the sea varies uniformly, we have the same form of relation between the boiling point and the barometric pressure as between the height above the sea and the barometric pressure, namely, that each is as the logarithm of the other. Hence the boiling point falls *exactly* in proportion to the height ascended, and at the rate of 549.5 feet for 1° Fahr.

The following Donations of Books to the Society's Library were announced.

Monthly Notices of the Astronomical Society of London, containing Abstracts of Papers and Reports of the Proceedings of the Society. Vols. 1, 2, 3, 4, and vol. 5. Nos. 1–27.

Memoirs of the Royal Astronomical Society. Vol. XIV.—*By the Society.*

Examination Papers of the several Faculties in the University of London, for 1842.—*By the Council of the University.*

Mémoire sur la Chaleur des Gas Permanens, par Jean Plana, Astronome Royal, et Directeur de l'Observatoire de Turin.—*By the Author.*

Journal of the Asiatic Society of Bengal. Nos. 124 and 125, for 1842.—*By the Society.*

The Quarterly Journal of Agriculture, and the Prize Essays and Transactions of the Highland and Agricultural Society of Scotland. No. 60, for March 1843.

The following Donation to the Museum was presented—

A Specimen of a Vegetable Impression from Burdie House.—*Presented by D. Balfour, Esq. younger of Trenaby.*

The following Gentlemen were duly admitted Ordinary Fellows of the Society:—

Andrew Coventry, Esq., Advocate.
D. Balfour, Esq. younger of Trenaby.

Monday, 20th March 1843.

Sir DAVID BREWSTER, Vice-President, in the Chair.

The following communication was read:—

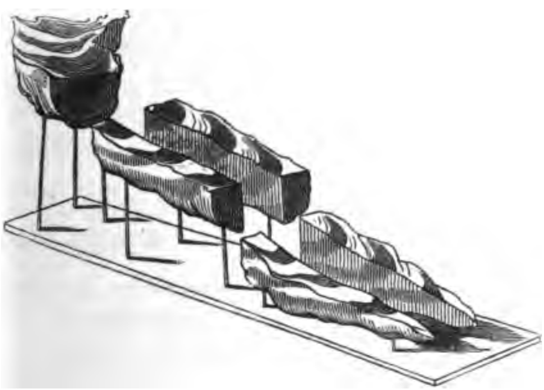
Papers on Glaciers. No. 3, On the Structure of Glaciers, and the cause of their motion. By Professor Forbes.

With reference to his former paper of the 27th February, the author stated, that he had received a most satisfactory confirmation of his opinion respecting the motion of glaciers in winter. From observations made by his direction on the Mer de Glace of Chamouni, and in which he places entire confidence, it appears that the ice moved no less than 76 feet between the 12th December 1842 and 17th February 1843, or at the rate of 13½ inches *per diem*, whilst its mean motion during the summer was 17½ inches.

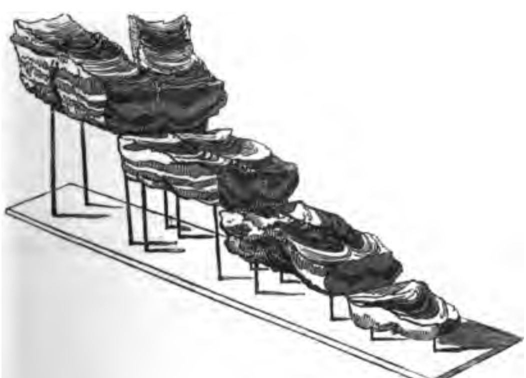
The author then explained the manner in which he conceives the conoidal structure of glaciers to be due to the varying velocity of different points of their section producing discontinuity by minute fissures, which are infiltrated and ultimately frozen. He had before satisfied himself that the forms of these surfaces are such as the motion of the particles of a viscid fluid, obstructed by the sides and bottom of the canal in which it moves, would engender. But to make this more palpable, he has endeavoured to imitate the motion of a glacier, by causing a plastic fluid of different colours to mould itself by the action of gravity in an inclined bed, and he has thus succeeded in reproducing the forms of the structural surfaces of glaciers so precisely that they cannot be distinguished from the curves which he had drawn as representing the actual phenomena.—*See Edinburgh Philosophical Journal*, Oct. 1842, pages 346, 347.

ILLUSTRATIONS OF THE VEINED STRUCTURE OF GLACIERS.

View of a Glacier, shewing its Structure by Ideal Sections.



View of a Model shewing the curves generated (experimentally) by the motion of a viscous fluid.



View of a Model shewing the effect of the union of two streams on the motion of a viscid fluid.

Professor Forbes also mentioned the objection recently taken by M. Agassiz to this theory of the veined structure being due to the different velocity of parallel portions of the ice, namely, that where two glacier streamers unite, their structure remains separate and distinct. Professor Forbes admits that it does so for a certain distance after union, but affirms, that, if the glacier be long enough, the structure always tends to consist of a single series of curves. He shewed, by models formed by the union of two plastic streams, that, in point of fact, such phenomena of united streams may be reproduced, the double structure being very slowly worn out, in consequence of the nearly uniform movement of the middle part of the stream.

Professor Forbes recapitulated the proofs that the glacier moves as a plastic mass, the friction of whose parts is less than their friction upon the surface over which they tend to slide; and he bases his theory upon three classes of facts, which he considers that he has demonstrated. 1. That the glacier moves like a stream, fastest at the centre. 2. That its velocity is immediately governed by the external temperature and the state of infiltration of the ice by water at the time. 3. That the forms which its veined structure assumes are those due to the movement of a semi-solid mass in the manner supposed.

The following Donations of Books to the Society's Library were announced.

Archives du Museum d'Histoire Naturelle, publiées par les Professeurs-Administrateurs de cet Etablissement. Tome ii. Liv. 3.—*By the Editors.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Tome xv. Nos. 9-26, et Tome xvi. Nos. 1-7. —*By the Academy.*

Monthly Notices of the Astronomical Society of London. Vol. v. No. 28.—*By the Society.*

Specimen de l'Imprimerie de Bachelier, Rue de Jardinet.—*By M. Bachelier.*

Henry Stephens, Esq. was duly elected an Ordinary Fellow of the Society.

Monday, 27th March 1843.

Dr ABERCROMBIE, Vice-President, in the Chair.

The following communications were read:—

1. Observations on the Temperature and Hygrometric state of the Island of Barbadoes. By R. Lawson, Esq., Assistant-Surgeon of H. M. 47th Regiment. Communicated by Henry Marshall, Esq.

This paper contains an account of the Thermometric and Hygrometric observations made at the Barbadoes, from May 1841 to January 1842. The instruments were carefully verified and observed; and, during three months, the temperature was ascertained for 18 hours out of the 24. The author thence deduces the form of the daily curve of temperature for that period.

2. On the Growth and Migration of the Sea-Trout (Salmo Trutta). By Mr John Shaw, Drumlanrig. Communicated by James Wilson, Esq.

The author has here pursued the same course of experimental enquiry regarding the sea-trout, as that formerly followed in relation to the salmon. Having obtained impregnated ova, from a pair of spawning fish, he conveyed these ova to his experimental ponds. This was on 1st November 1839, and the young were excluded from the egg in 75 days. They resembled salmon of the same age, but were somewhat smaller and paler. They took two years to grow about seven inches, and the majority were then converted into smolts. But about one-fourth did not assume the silvery lustre; and this peculiarity, Mr Shaw thinks, distinguishes a like proportion even in the rivers. He then experimented on the smolts in the natural streams, and found, that, after descending to the sea, they returned as *herlings* (*Salmo albus* of Dr Fleming) in July and August, with an addition to their weight of seven or eight ounces. These herlings spawn towards the end of the season of their first ascent; and, after revisiting the sea, they ascend the rivers again in the ensuing months of May and June, with an average weight of 2½ lb. This increase takes place almost entirely in the sea. After spawning for the second time, they descend for the third time to

the sea, and make their appearance again in fresh water in the course of the ensuing summer, weighing 4 lbs. They are now in their fifth year, including the two seasons they had passed as fry, anterior to the assumption of the migratory dress and instinct. Descending seawards for the fourth time, they weigh about 6 lbs., when next seen in the rivers, in the course of their sixth summer. These at least were the progressive changes and ratio of increase observed by Mr Shaw, in specimens distinctively marked, and carefully noted, when retaken in the river Nith successively from year to year. The peculiar marks imposed each season are detailed in his paper, and the whole subject is illustrated by an extensive series of specimens, from the day of hatching, to the middle of the sixth year. These specimens are now in the Society's Museum.

3. Experiments with Hydro- and Thermo-Electric Currents; and an Examination of Metals long exposed to Thermo-Electric Currents. By R. Adie, Esq. Communicated by Dr Traill.

The author commences his paper with a description of two forms of Electric Batteries, which he used in his experiments, and which consisted of bars of antimony and bismuth. One of these, which was chiefly intended for currents excited by solar and astral influences, was so delicate as to make the needle of the galvanometer deflect at right angles, when one end of the battery was exposed to the influence of clear summer's sun; and he therefore considers it a very delicate meteorological instrument. The other form of battery was principally used for thermo-electric currents, from a low flame of gas, or a spirit-lamp.

With the former instrument he succeeded in decomposing cyanide of silver, by exposure to the air for three months in winter, even although the voltameter, in connection with the battery, was often exposed to frost.

In using the second form of instrument, he remarked, that water is decomposed by copper poles, but not by poles of platinum,—a fact, which appears to him to account for Professor Daniell not having been able to produce electrolysis by primary thermo-currents. He farther observed, that metallic salts yield readily to a thermo-current, when the poles consist of the metal whose oxide forms the base of the salt.

On examining the effect of long-continued electrolysis on the

metals constituting the battery, he found that no appreciable change was caused in the antimony by a current maintained for four months, and strong enough to cause, in 164 days, the deposition of a quantity of copper in the voltameter, equal to the weight of the battery. But the junctures of the bismuth and antimony, which were soldered by pure bismuth, presented an important change, even in thirty or forty days,—the bismuth soldering having undergone a species of disintegration, so that the antimonial bar was easily separated, and the surface of the bismuth lost its crystalline appearance, and might be rubbed off in the form of a fine powder. The author proved, that this change could not be the effect merely of the heat to which the metals were exposed, but is truly an electric phenomenon. Changes were also found to be effected, by long-continued electric currents, in the specific gravity of the metals. Antimony had its density raised, after exposure for twenty-two days to a thermo-electric current, from 6.645 to 6.670; and the density of bismuth was diminished from 9.853 to 9.838.

In pursuing his experiments with hydro-currents, he found, that the elimination of hydrogen from a copper wire soon comes to an end under the influence of pressure caused by the accumulation of gas in a hermetically sealed space around the wire, while the deposition of copper goes on. By hydro-currents, aided by pressure, he obtained leaf-like deposits of metal, in solutions of common salt, with poles of copper, tin, silver, and zinc, and pulverulent deposits with gold, mercury, antimony, cobalt, platinum, and arsenic. But when iron, bismuth, cadmium, and nickel were used, no deposition took place,—the hydrogen continuing to be disengaged, till the voltameter burst.

To these investigations the author added some experiments on the effects of quick and slow cooling, in altering the densities of metals. He found, that antimony loses in density by sudden cooling; that this metal, and also bismuth, do not gain in density by slow cooling; that by this process the density of lead, tin, and zinc is increased; that copper and silver are densest when allowed to cool slowly; that iron undergoes no change by slow cooling, unless first heated very strongly, in which case its density is diminished; and that steel loses in density by the process of hardening, but does not lose by repeated heating.

Lastly, in conformity with the experiments of Bequerel, on the developement of electric currents, by sudden alterations in the density of metals, the author found, that, when the density of gold, pla-

tinum, cadmium, silver, and iron, was increased, by passing them through the drawing-plate, a deflection of from one to four degrees was occasioned in the galvanometer: but with lead and tin no perceptible deflection was occasioned.

The following Donations of Books to the Society's Library were announced.

Bulletin des Séances de la Société Vaudoise des Sciences Naturelles. Nos. 1 & 4.—*By the Society.*

Essai Historique sur les Phénomènes et les Doctrines de l'Electro-Chimie. Par Elie Francois Wartmann.—*By the Author.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Tome XVI. Nos. 8 & 9.—*By the Society.*

On the Transparency of the Atmosphere and the Law of Extinction of the Solar Rays in passing through it. By James D. Forbes, F.R.S. &c.—*By the Author.*

The following Donations to the Museum were presented—

Specimens of the Hyperstene Rocks of the Cullin Hills, and of the Limestone and Dykes traversing the Cullen Hills at Kilbride, Isle of Skye. Collected by G. Bellas Greenough, Esq.—*Presented by Lord Greenock.*

Specimens of the Calcareous Formation of the Bermudas and Bahama Islands. Collected by Lieut.-Colonel Emmett, R.E.—*Presented by Lord Greenock.*

Monday, 3d April 1843.

Sir T. MAKDOUGALL BRISBANE, Bart., President, in the Chair.

The following communications were read:—

1. Chemical Observations on the Flowers of the Camellia Japonica, Magnolia Grandiflora, and Chrysanthemum Leucanthemum, and on three Proximate Principles which they contain.—*Conclusion.* By Dr Hope.

The author first called the attention of the meeting to the principal facts which he had established in the two memoirs read to the Society in the year 1836. 1*st*, Of these the most important are, that when acids cause a red colour, and alkalis a green or yellow, in a blue vegetable infusion, they act on differ-·· substances;—the acids or

erythrogen, and the alkalis on xanthogen. *2dly*, That the compound of alkalis and xanthogen is of a yellow colour, and that when a blue infusion is changed to green, it is owing to the gradual intermixture of the newly generated yellow with the original blue.

Camellia Japonica.—The blossoms of the beautiful double white Camellia Japonica are remarkable for the peculiar matters which they contain, two of which appear to be distinct vegetable principles. When a parcel of the petals is infused in boiling-hot water, and digested for some time, a nearly colourless infusion is obtained, which is not visibly affected by acids. When solution of potash is added, a light orange colour appears, which gradually deepens, till in a few hours it acquires a very deep orange hue. Solution of ammonia causes a similar effect. When lime-water is employed, it produces turbidity in the infusion, and a pinkish red colour. This colour gradually assumes a richer tint, and in about 24 hours exhibits a deep pinkish red. The author has applied the same alkalescent agents to above 150 flowers, both white and coloured, without observing any similar effect.

To this colourable matter he gives the name of Cammelline. The author tried the effects of various reagents, but no interesting facts resulted.

When any portion of the flower-leaf is bruised, whether remaining on the parent plant or removed from it, it immediately begins to assume a rusty or ochry tint, which grows deeper and deeper, till it arrives at the tint of perfect ochre.

By various experiments, it was proved that this change of colour depends upon the action of the oxygen of the air. It takes place in a very remarkable degree in oxygen gas, and does not take place at all when the contact of air is excluded by an immersion in mercury, in hydrogen, or carbonic acid gas. To this brown-growing matter, viewing it as a distinct vegetable principle, Dr Hope gave the name of Magnoline, in consequence of its occurring in a very remarkable degree in the Magnolia grandiflora and Magnolia conspicua. A third remarkable circumstance respecting the Camellia petals, is, that they contain a notable quantity of iron. This was little to be expected, seeing that iron is so common a source of colour, and the blossom is entirely colourless. The author was led to search for this metal in consequence of the strong resemblance which the colour which protoxide and protocarbonate of iron acquire by the absorption of oxygen from the air, and the colour acquired by the bruised petals of the Camellia bear to each other. Dr Hope is satisfied that the ochry

tints of the Camellia are in no way dependent on, or connected with, the iron which it contains.

Magnolia Grandiflora. — When the petals of the *Magnolia Grandiflora* are boiled for some time in distilled water, a liquor of a very light yellowish brown is obtained. This colour is banished by sulphuric acid. Solution of potassa immediately causes a deep gall-stone yellow, shewing that this, like other white flowers, contains no erythrogen, but abounds in xanthogen. That matter, which becomes of an ochry hue by the contact of air, is very abundant in the Magnolia, so that, if the cuticle be scraped off, in less than a minute the place of abrasion exhibits the ochry tint. The petals of the snow-white *Magnolia conspicua* exhibit the same phenomena in a still more remarkable degree. If a petal of this beautiful flower be bruised between the fingers and thumb it immediately becomes of a very deep brown, and ere long almost black. Some other white flowers, by being crushed and exposed to the air, also acquire the ochry tint, but in a much inferior degree to those already mentioned. The ochry-growing matter is not confined to white flowers. It exists in different species of the blue flowers of the Aconitum, particularly the napellus.

The third flower of which Dr Hope gave an account, was the *Chrysanthemum leucanthemum*, the ox-eye daisy. A strong decoction of the white petals exhibits a light brown colour, which potash quickly converts into the usual gallstone yellow. When sulphuric acid is dropped into this decoction, the colour becomes a light primrose yellow, and the liquid immediately assumes a gelatinous state. This jelly gradually becomes more consistent, and, in about a quarter of an hour, it is so firm that the capsule containing it may be inverted without the jelly falling out. The matter thus gelatinized by sulphuric acid is peculiar to this plant. The author has applied sulphuric acid to the infusion of at least 150 flowers, without any similar result taking place. The author conceives that the gelatinising matter is a distinct vegetable principle, to which he gave the name of Leucanthemine. To support this view, he drew a comparison between it and the coagulable matters both of the animal and vegetable kingdoms, viz. animal albumen, casein, fibrin, and vegetable albumen. In drawing this comparison, the author described some remarkable properties of these albuminous matters, which have escaped the observation of all the investigators of the chemistry of organic substances, and some of which he had been in the habit of exhibiting in his lectures for nearly half a century. These are, principally, that

sulphuric acid dissolves the albuminous matters in the cold, and yields a nearly colourless solution, without altering the nature of the albumen. But if the liquor be heated to 160°, it acquires an extremely beautiful rich crimson hue, during which change the nature of the albumen is totally altered. Muriatic acid acts upon albuminous matter nearly in the same manner; but the colour which the solution acquires by being heated is a very rich purple. The jelly from the Leucanthemum affords no crimson colour with sulphuric acid. After pointing out other circumstances of difference, the author gave his opinion that the Leucanthemine ought to be considered as a distinct substance *sui generis*, another vegetable principle; and concluded with expressing his hope that the Camellia, Magnolia, and Chrysanthemum furnish three to the long list of vegetable proximate principles.

2. On certain Negative Actions of Light. By Professor Moser of Kœnigsberg. In a Letter to Sir David Brewster.

"There are certain actions of light which may be called *negative actions*. By this name I mean to indicate a series of *new actions*, without pretending to enter into any theoretical considerations. In acting upon an iodised plate, common light produces successively different states, which are made manifest by exposing the plate, when taken out of the camera, to the vapours of mercury. If the plate has remained in the camera but a short time, we shall see only the first traces of an image. The parts most strongly affected by the light condense the mercurial vapour only in small quantities. If the light acts during a longer time, the image will appear with more details and more distinctly, the mercurial vapours being condensed more abundantly. By increasing the time of action, the image gains in details, but the parts which have been affected with a strong light condense the mercurial vapours in smaller quantities. The images that exhibit many details have usually at the same time a grey aspect, arising from the mercurial vapours having already begun to blacken the iodised silver. If the plate remains still longer in the camera, it does not present any visible image; but when exposed to the mercurial vapours, there is produced an image wholly *negative*. The parts which have been too long acted upon by an intense light condense little vapour, and hence become completely *black*, while the parts which were in shadow condense much vapour, and appear *white*. Hence arises the peculiar aspect of the image. When this period of

action is exceeded, the plate comes out of the camera with a visible image, which the vapours of mercury scarcely affect. This species of images is well known to experimentalists, and they have not hitherto been applied to any useful purpose.

"Now, when any one of the above *states* of the image has taken place, we may always, and easily, cause the image to retrograde on the plate, and arrest it at any anterior state we please. For example, I leave the iodised plate 300 minutes and more in the camera, whereas 10 minutes are sufficient to produce an ordinary Daguerreotype picture. When this plate is withdrawn from the camera, it presents a distinct negative image. I then expose the plate during 22 seconds to the vapours of *iodine*, and then to those of *mercury*, and the result of this is the production of a splendid Daguerreotype picture. The vapour of the iodine has, therefore, caused the action of the light to *retrograde*. I have repeated and varied these experiments in every way, and always with the same success, taking care not to allow the vapours of iodine to act too long, otherwise they would completely destroy the action of the light.

"There are many other bodies which, in their gaseous state, produce the same negative actions, when applied to an iodised plate, such as *chlorine*, *bromine*, the *hydro-fluoric acid*, &c. &c.; but I shal not enlarge on this point, because I have to mention to you a gas much more interesting, viz. *oxygen*, which exercises the same negative action.

"Having left the iodised plate from *four* to *six* times the period necessary for an ordinary picture in the camera, and exposed it to *pure oxygen* during a few seconds, the mercurial vapours produce the ordinary image. The oxygen in atmospheric air acts also upon the plate, and requires only that the action be prolonged. If we expose a plate with an image that would become *negative* by mercurial vapour, during *one* or *two* minutes, to a current of air from a pair of bellows that would raise a column of water *four* or *five* inches high, the image will be presently brought back to its ordinary state; or if the blast is continued longer, to any other anterior state, the primordial state not excepted. Atmospheric air, indeed, quite calm, exercises also these negative actions, provided its action is continued for some hours.

"I may also add, that among the gases which compose atmospheric air, oxygen alone produces these negative effects. Nitrogen, carbonic acid, and the vapour of water, do not produce them; the latter, however, produces the effects which I have described in my Memoir

on the Latent State of Light. These negative actions are never produced by any of the rays of solar light.

"It appears to me that these new facts, of which I have communicated to you the most remarkable, lead to important results. It naturally follows from them, that the oxygen of the atmosphere will retard the action of light, and tend to preserve the surfaces of bodies in their primordial condition. I have, without success, endeavoured to make a direct experiment on this subject. I placed a camera-obscura under the receiver of an air-pump, and exhausted the air; the time, however, for producing any particular effect of light did not change; but the air-pump was so imperfect, that it did not produce a rarefaction beyond five or six inches of the barometer. In the mean time, however, I may adduce some of my experiments communicated seven months ago to the Academy of Sciences at Berlin, which prove, at least indirectly, what the air-pump has not yet verified. If we wet an iodised plate of silver with *any fat oil*, we shall find that the time in which light produces any particular effect is greatly diminished. In applying, for example, *oil of olives*, the plate will be four or five times more sensitive; so that, instead of four or five minutes, *one* minute only will be necessary to produce the same effect in the camera. The mercurial vapour readily penetrates the thin film of oil, and produces very perfect images. This singular action of oils arises probably from their obstructing, or, at least, enfeebling, the negative action of oxygen gas. The mercurial vapours produce even a better developed image, that is to say, one which corresponds to a more prolonged action of light, if we apply the oil only at the instant the plate is taken out of the camera.

"I believe that these negative actions, which bring back the surfaces of bodies to their natural state, will throw some light upon the process of vision, because the same effects seem to take place upon the retina. But I greatly regret that I am not able to enter into any details on this interesting subject, as I am wholly occupied with other researches, particularly on a very remarkable and different kind of action exerted by *hydrogen gas*."

3. On the Specific Gravity of certain Substances commonly considered lighter than Water. By Dr Davy.

The author enters on the subject by adverting to the apparent lightness imparted to the common woods, and to certain vesicular minerals, by the entanglement of air in their substance, as is commonly understood, and as is proved by the action of the air-pump.

The specific gravity of oak-wood, after having been kept under the exhausted receiver till it sunk in water, and ceased to give off air, he found to be (inclusive of hygrometric moisture) 1.58 ; that of deal, 1.18, or when crushed about 1.5; that of the pith of the elder, 1.45; and that of pumice, 1.94, or crushed, 2.41, which is nearly the same as that of obsidian, from which pumice appears to be formed by the action of volcanic fire.

Reasoning analogically, the question naturally occurred, are there not other substances, commonly considered lighter than water, which are so only in appearance, owing, it may be, to air adhering to their surface, or included in them, such as cork, caoutchouc, camphor, wax, spermaceti, cholesterine, stearine ?

Cork, he finds, continues to float on water, after having been kept under the exhausted receiver nearly two months. This he attributes to the elasticity of the plates constituting its cells, confining a very minute quantity of air, that cannot be extracted by the pump. When the cells are broken, it sinks in water. From indirect experiments, he infers its specific gravity to be about 1.6, or nearly the same as that of lignin.

In common caoutchouc, he detected the presence of air by the microscope, which, owing to the peculiar quality of this substance, could not be separated either by the air-pump, or by compression, or by boiling. Dissolved in ether, and precipitated by alcohol, he found it apparently of specific gravity .97 ; allowing for circumstances interfering with accuracy of result, he conjectures that the specific gravity of caoutchouc is about the same as that of water.

The specific gravity of camphor, he concludes from his experiments, to exceed a very little that of water, viz. as 1.005 to 1.000; that of bees' wax, and also that of spermaceti and of stearine, to be about the same as that of water at the temperature 50°, though considerably lighter at the boiling temperature of water; and that of cholesterine to be a little higher, viz. 1.0102.

In conclusion, he expresses the opinion, that attention to the specific gravities of the substances under consideration, may be useful in conducting chemical analyses of compound bodies in which they may be contained; that a consideration of the cause of their apparent lightness, viz. included or adhering air, may help to explain some rather obscure phenomena,—as the raising of cream, &c.; and that attention may be deserving of being paid to the same cause, as exemplified in the substances treated of, whenever, in works of art, unusual lightness or buoyancy is a desideratum.

The following Donations to the Society's Library were announced.

Scheikundige Onderzoekingen, gedaan in het Laboratorium der Utrechtsche Hoogeschool. St. 5.—*By the Author.*

Natuurkundige Verhandelingen van de Hollandsche Maatschappij der Wettenschappen te Haarlem. Deel. 2.—*By the Society.*

The following Donations to the Museum were presented—

Series of Specimens of the different Rock Formations. (150 specimens.)—*Presented by Lord Greenock.*

Specimens connected with Mr Shaw's paper on the Development and Growth of the Sea-Trout of the Solway.—*Presented by Mr John Shaw.*

Monday, 17*th April* 1843.

The Right Honourable Lord GREENOCK, Vice-President, in the Chair.

The following Communications were read :—

1. On the presence of Organic Matter in the purest Waters from Terrestrial Sources. By Professor Connell.

It must be well known to chemists, that when solution of acetate of lead is added to the transparent and colourless water of springs, wells, and rivers, a more or less dense white cloud is almost invariably produced. This reaction has been usually attributed to the presence of inorganic salts, such as carbonates, sulphates, and muriates ; but it will be found that, generally speaking, this precipitate is formed even after the water has been boiled ; that it is usually dissolved by the speedy addition of a drop or two either of acetic or of nitric acid, without visible effervescence ; and that the agency of the water with nitrate of silver is commonly too small to admit of its being caused by any muriate. These facts exclude the idea that it is due in the general case to carbonates, sulphates, phosphates, or muriates ; although, of course, in those particular cases where the water has enough of such constituents to affect acetate of lead, the reactions will be modified accordingly. Thus, in some cases, where the first action is as above stated, a deposition takes place after a certain interval of sulphate of lead, no longer soluble in weak acids.

It occurred to the author that the true cause of the reaction was to be found in the presence of organic matter in the water, derived from the decomposition of vegetable matter in the strata or soil through which it had passed. To ascertain whether this view was correct, the precipitate by acetate of lead from several quarts of the town water of St Andrews was decomposed by sulphuretted hydrogen. After filtration, a liquid was obtained, which, besides sulphuric acid derived from precipitated sulphate of lead, was found to contain some organic matter apparently of an azotised nature; but its amount was too small to characterise its properties with accuracy. The salt obtained by saturating the liquid with potash, yielded by distillation empyreumatic vapour, and left a black coaly mass behind. The liquid itself, when neutralized and sufficiently diluted, had still a marked action on lead salts; and it or its potash salt produced more or less precipitate after the interval of a day or two, in acetate of copper and neutralized persulphate of iron.

The author has found this matter in the town waters of Edinburgh and Glasgow, but to a less extent than in that of St Andrews. The Glasgow water shewed the least of the three. He has also found it more or less in every instance he has hitherto tried of transparent and colourless well, spring, or river water. In rain water it does not exist, and probably could not be found in springs above the limits of vegetation, or in snow or glacier water. It would seem that it ought to perform functions of some importance in the economy of nature, as contributing in a certain degree to the nourishment of plants and even of animals.

2. Biographical Sketch of the late Sir Charles Bell. By Sir John MacNeill.

This paper is, from its nature, incapable of being here given in an abridged form.

3. Notice regarding the Bebeeru Tree of British Guiana. By Dr A. Douglas Maclagan.

The plant bearing the above Indian name, and also called Sipeeri by the Dutch colonists, furnishes the hard and heavy timber known by the name of Greenheart. The object of the present paper was to state the result of experiments made by the author on the bark and seeds of the tree, which had been found by Mr Rodie, R. N., to contain a vegetable alkali possessed of the power of checking intermit-

tent fevers. Dr Maclagan stated that the tree was unknown to botanists. Sir William Hooker and Dr Lindley had seen the fruit and declared it to be lauraceous, but the author had been unable to find, in Rees v. Esenbeck's *Systema Laurinarum*, any genus or even suborder of lauraceous plants to which he could refer it. With regard to its chemical qualities, Dr M. stated that he had obtained both from the bark and seeds two distinct alkalis, both uncrystallizable, to one of which he applied Mr Rodie's name, Bebeerine; to the other he gave the name of Sipeerine. They could be separated by anhydrous ether, the bebeerine being soluble in that menstruum, whilst the sipeerine was not. Dr M. had likewise obtained, especially from the seeds, a peculiar crystallizable and deliquescent acid, which he called Bebeeric acid, and which seemed to be distinct from every vegetable acid hitherto described.

The author stated that he had instituted experiments with a view to ascertain if a soluble salt of the alkalis could be procured, which might be used as a substitute for sulphate of quinine when dear. He stated, as the result of his trials, that the produce did not amount to more than one and a-half of sulphate per cent. from the bark, but he still calculated that if the bark could be got at a moderate price, the salt of the alkalis might be prepared at a cost inferior to that of sulphate of quinine. Dr Maclagan stated that the bark appeared to be better suited for the purposes of manufacture than the seeds. The author mentioned that sulphate prepared under his directions had been sent out to Demerara, and had been tried there with marked success in intermittent fever by Dr Watt; he had likewise used it with success in a few cases of ague in Edinburgh, and also in periodic headache, so that he had no doubt of its possessing considerable power as an antiperiodic remedy. Lastly, he mentioned that a secret preparation sold under the name of "Warburg's Fever Drops," reputed a good antiperiodic, appeared to him to be a tincture of bebeeru seeds.

W. H. Norie, Esq., was duly elected an Ordinary Fellow of the Society.

The following Donations for the Society's Library were announced.

The Quarterly Journal of Meteorology and Physical Science. Edited by J. W. G. Gutch, M. R. C. S. No. 6. for April 1843.—*By the Editor.*

Proceedings of the London Electrical Society. Part 8.—*By the Society.*

Annual Report of the Council of the Yorkshire Philosophical Society, for 1842.—*By the Society.*

Elements of Agricultural Chemistry. By Sir Humphrey Davy, Bart. (Sixth Edition.)—*By Dr John Davy.*

Proceedings of the Royal Astronomical Society. Vol. V. No. 29. —*By the Society.*

Proceedings of the Royal Society. Nos. 55 & 56.

Revised Instructions for the use of the Magnetic and Meteorological Observatories, and for the Magnetic Surveys. Prepared by the Committee of Physics and Meteorology of the Royal Society.—*By the Royal Society.*

Monday, 1*st May* 1843.

Sir T. M. BRISBANE, Bart., President, in the Chair.

The following Communications were read :—

1. An attempt to explain the Phenomena of the Freezing Cavern at Orenburg. By Dr Hope.

Dr Hope in the first place read, from the Proceedings of the Geological Society in London, the account of the freezing cavern furnished by the President of the Geological Society of London. This is one of several caves which exist in the southern face of a lengthened low hillock of gypsum. It is entered from the south by a passage rather narrow, and is about fifteen feet high, ten paces long, and seven wide, which seemed to send off irregular fissures into the body of the rock.

The extraordinary feature of this cavern is, that during summer it is so cold that ice is generated in it, and dry icicles hang from its roof; and that, in winter, all appearance of congelation ceases, and the temperature becomes such that the Russians say they could sleep in it without their sheep-skins.

Mr Murchison applied to Sir John Herschel for an explanation, and the theory which he proposed is, that the heat and cold of the surface gradually move, though very slowly, backward into the rock;

that it requires six months for the wave of cold, as he terms it, to reach the cavern, and consequently, that that frigid wave begins to arrive at the commencement of summer, and continues during that season, occasioning such a degree of cold in the cavern as to produce the congelations described by Mr Murchison.

At the commencement of winter, the first effect of the summer's heat arrives, and continues without interruption, and occasions warmth enough to prevent congelation.

Dr Hope entirely concurred with Sir John Herschel in thinking that alternate waves of heat and cold must exist and have a share in producing the phenomena, and in corroboration quoted the observations of Saussure, that at Geneva the winter's cold requires six months to descend 29½ feet, and that the summer's heat penetrates to the same depth in a similar period of time; the maximum of cold taking place at mid-summer, and of heat at mid-winter.

But he also expressed his conviction that these alternate waves were not sufficient to account for the phenomena, further remarking, that were they the only powers employed, the paradoxical phenomena should occur equally in some of the other caverns of the Orenburg hillock, or in other caverns in different quarters of the globe. He observed, that there must be something peculiar to the Illetykaya Zatchita cavern which renders it the only cave in the world which possesses the singular property, so far as he knew. He then alluded to the caverns in different parts of the globe in which accumulations of snow are found in summer, and concurred with Mr Murchison in thinking that they have no analogy with that of Orenburg. They are merely receptacles of the winter snow and ice, and preserve it during summer, after the manner of an ice-house.

The circumstance peculiar to the Orenburg cave is the occurrence of the rents and fissures which rise from the back part of the cavern.

The author stated, that if it were granted that these fissures reach the surface, even by the smallest ramifications, and that they ascend within the reach of the alternate waves of heat and cold, the whole phenomena may be easily and satisfactorily explained. He ascribed the summer's coldness and congelation to a constant current of cold air through the fissures of the rock into the cavern; and he supposed that the current is occasioned in the following manner: When

at the close of spring the temperature of the external air and of that in the rents is the same, no particular occurrence takes place; but as soon as the wave of cold begins to make impression on the rocky parietes of the fissures, then the air in them will be somewhat cooled, contracted, and rendered specifically heavier. This being so, the weight of the column of air in these rents will be greater than that of a column of equal altitude of the external atmospheric air, and the consequence will necessarily be, that the colder air will descend, the warmer atmospheric air from above will supply its place, which, in its turn, will be cooled and descend, and thus a current of cold air through the crevices into and through the cavern will be established. As the temperature of the rocky parietes gradually falls with each successive wave of cold, the air in the fissures will become colder and colder, and in the same proportion will descend more rapidly.

But the rapidity of descent does not only depend upon the increasing coldness of the air in the fissures, but is further augmented by the warmth of the summer expanding the external air, so that the difference of weight between the external and internal columns becomes greater. In the manner now explained, a current of cold air is constantly descending and flowing through the cavern, producing all the surprising frigorific effects displayed within it.

That such a current does exist, Mr Murchison gives a satisfactory proof; he says, "That upon unlocking the frail door of the cavern, a volume of air, so surpassingly keen, struck the legs and the feet, that he was glad to rush into a cold bath in front of him to equalize the effect." This downward current will continue the same till the close of autumn, when its course comes to be changed; by that time the first approaches of May's surface warmth will begin to be experienced, the cold of the sides of the rents begins to diminish, and the temperature of the external air must have fallen to nearly that of the internal current. As soon as an equality between the temperatures and densities of the external and internal columns shall have been established, all current must cease. At this period, namely, the commencement of winter, the wave of the summer's heat begins to reach both the walls of the air-channels and of the cavern, and gradually communicates a warmth which progressively elevates the temperature, and dissipates every mark of the preceding summer's congelation. It might at first be reasonably expected, that at this time the preceding order of things would be reversed, and that a current in the opposite direction would

commence, such as, it is known, happens in many mines; for, undoubtedly, the temperature of the atmosphere descending rapidly, the gravity of the external air would soon exceed that of the internal column. A current would immediately commence from below, and, entering from the cavern door and ascending through the rents, escape at the surface. The consequence of such a current would be, that the cold would soon reappear in the cave, and gradually increase during the severity of the winter, and completely overpower the heating influence of the thermal wave, now beginning to operate on the walls of the cavern, and so prevent the warmth of the cave during winter.

An occurrence, however, now takes place which puts a stop to the upward draught, and permits the thermal wave to have its full influence on the temperature of the cavern. The winter commences with repeated falls of snow, which form a thick covering on the surface of the earth, and closes up all the communications between the extremities of the crevices and the external air, and no current can take place. In this manner the influx of the intensely cold air into the cavern, and its ascent through the fissures, is prevented, and then full play is given to the calorific power of the wave of heat which continues to arrive in the cavern through its rocky sides during the whole continuance of winter, and communicates the warmth recorded by Mr Murchison. In the beginning of summer the snows melt, and the terminations and ramifications of the fissures have their communication with the atmosphere restored. The currents, as already described, are re-established, and all the paradoxical phenomena to which they give birth present themselves in due succession.

2. Observations on the Temperature of the Earth in India. By John Caldecott, Esq. Communicated in a Letter to Professor Forbes.

These thermometers, made by Mr Adie of Edinburgh, were sunk in the ground at Trevandrum, in lat. 8° 30′ 35″, to depths of 3, 6, and 12 *French* feet. Mr Caldecott says,—" I send you herewith the readings of my long thermometers, which, from various causes, I was not able to put into the ground until the 1st of last May (1842). These two months' readings, therefore, will not, of course, have the proper temperature at the respective depths, especially as it has been raining more or less nearly ever since. Still, I think

they will surprise you, as being (so far as they go) entirely opposed to Kupffer's opinion, that the superficial temperature of the earth within the tropics is *below* that of the air, and to Boussingault's assertion, as to the invariability of the temperature *one foot* below the surface. The soil in which the thermometers are buried, is one which very soon becomes compact again, after having been disturbed, so that I do not think the rain can much affect the thermometers *now* * * * * . The situation is on the top of the Observatory hill; the soil, the stone called Laterite."

A subsequent letter contains the readings for four entire months, and confirms the important conclusions mentioned above. The mean annual temperature of the air at Trevandrum is 79°.24 F.

1842.	12 Feet.	6 Feet.	3 Feet.	Air.
May	84.672	85.157	83.820	80.09
June	...	84.562	82.062	79.32
July	84.805	83.627	81.025	78.73
August	84.240	82.800	80.220	77.90

The surface of the ground was grass-grown, and the thermometer stems quite exposed.

3. Researches in Hydrodynamics. Second Memoir. On Waves. By J. Scott Russell, Esq., M.A., F.R.S.Ed., &c.

The object proposed by the author of this paper, was to present, in a complete form, the results of investigations into the phenomena of Waves, in which he had been engaged for several years. A part of the experiments referred to in the paper, had been carried on by Sir John Robison, conjointly with the author of this paper, as a Committee of the British Association. The others were new, and had been carried on by himself, for the purpose of completing and giving that systematic form to our knowledge of the subject, which was attempted in this paper.

The author finds that there may exist in agitated water waves

different in kind, generated by different causes, propagated by different laws, and exhibiting different phenomena. These had not hitherto been sufficiently distinguished, and some of them were scarcely known. The following table exhibits the classification resulting from these investigations:—

Waves are of four Orders.

	Order I. The Wave of Translation.	Order II. Oscillating Waves.	Order III. Capillary Waves.	Order IV. Corpuscular Waves.
Characters.	Solitary.	Gregarious.	Gregarious.	Solitary.
Species.	Positive. Negative.	Stationary. Progressive.	Stationary. Progressive.	
Varieties.	Free. Forced.	Free. Forced.	Free. Forced.	
Instances.	The Primary Wave of Resistance. The Tide-Wave.	The Secondary Wave of Resistance. River Ripple. Wind Waves.	Dentate Waves. Zephyral Waves.	Wave of Sound through Water.

The rest of the paper consisted of the examination of the properties, and an explanation of the phenomena, of these four orders of waves.

The following Books, presented to the Library of the Royal Society of Edinburgh, were laid on the table—

Transactions of the Geological Society. (Second Series.) Vol. VI. Part 2.—*By the Society*.

Archives du Muséum d'Histoire Naturelle, publiées par les Professeurs-Administrateurs de cet Etablissement. Tome iii. Livr[ns] 1, 2.—*By the Editors*.

The following Donations to the Museum were announced—

A Head of Boodhoo in Dolomite from Ceylon.—*By Dr Davy*.

Specimens of Coal from Penteraclea, the Ancient Heraclea, on the Black Sea.—*By the Same*.

Specimen of "Burn Trout." *Salmo Fario*, taken from the Compensation Pond, weighing 6 lb.—*By James Miller, Esq*.

A Specimen of Chalcedony, from Iceland.—*By Sir G. S. Mackenzie*.

Six Specimens shewing the Action of Glaciers on Rocks:—

1. Limestone taken from under the Ice of the Glacier of La Brenva in Piedemont, in July 1842.
2. 3. 4. Specimens of Granite from the Grimsel, supposed to shew Glacier Polish.
5. 6. Specimens of Limestone from the Jura, shewing (supposed) Glacier Polish.—*By Professor Forbes.*

Specimens of Fossil Fish, from the Old Red Sandstone of Morayshire, named by M. Agassiz.—*By Prof. Forbes.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

1844. No. 23.

Monday, 4th December 1843.

Sir THOMAS BRISBANE, President, in the Chair.

The following communication was read:—

On the Influence of various Circumstances in Vegetation upon the activity of Plants. Part. II. The Umbelliferous Narcotics. By Dr Christison.

In the First Part of this inquiry, the author gave an account, in 1840, of some observations made by him, as to the influence of season on the activity of the acrid plants of the natural family *Ranunculaceæ*, and of the narcotics belonging to the family *Drupaceæ*.* In the Second Part now laid before the Society, he proceeded to relate a series of experiments instituted by him with the view of determining the influence of season on the activity of the poisonous narcotic plants of the family *Umbelliferæ*.

The plants belonging to this family are for the most part aromatic and stimulant, and destitute of poisonous properties. In four species only have narcotic properties been unequivocally recognised, viz., *Conium maculatum*, *Œnanthe crocata*, *Cicuta virosa*, and *Æthusa Cynapium*; but these are universally held to be highly energetic.

1. *Conium maculatum*, Common Hemlock.—No accurate information is yet possessed as to the influence of season on the activity of this species; for all investigations on the subject are vitiated by the uncertain strength of its preparations, and the ignorance which prevailed till very lately as to the conditions required for securing

* See the Society's Proceedings, 1840-41.

their uniformity. The author has found by experiment, as Professor Geiger had already been led to conclude, that every part of the plant is poisonous, both the root, the leaves, and the fruit; and that the root is least active, the leaves much more so, but the fruit the most active of all. The root is commonly held to be most active in midsummer, when the plant is in full vegetation and coming into flower; but this belief is founded only on a single, and not altogether conclusive, experiment made by *Professor Orfila*. The author found this part of the plant to be so feeble at all times, that its respective energy at different seasons could not be satisfactorily settled. The expressed juice of twelve ounces of roots had no appreciable effect on a small dog in the end of October or towards the close of June; but an alcoholic extract of six ounces in the beginning of May killed a rabbit in thirty-seven minutes, when introduced into the cellular tissue. The leaves are commonly thought to be most energetic when the plant is coming into flower in midsummer, and to be very feeble while it is young. The author finds it to be probable, that the leaves are very active in midsummer; but he has likewise observed, that they are eminently energetic in the young plant, both in the beginning of November, and in the month of March before vegetation starts on the approach of genial weather. Thirty-three grains of a carefully prepared alcoholic extract, representing one ounce and a third of fresh leaves, killed a rabbit in nine minutes, when introduced into the cellular tissue. The fruit is most active when it is full grown, but still green and juicy. It then yields much more of the active principle conia than afterwards when it is ripe and dry. The author added, as a fact contrary to general belief, that he had found the ripe seeds of hemlock, and an alcoholic extract of the leaves, to sustain no diminution in energy by keeping, at all events for eight years.

2. *Œnanthe crocata*, Dead-tongue.—This species is universally considered to be the most deadly of all the narcotic *Umbelliferæ*. Many instances of fatal poisoning with its roots have been published during the last two centuries, in the various periodicals of Europe. It has repeatedly proved fatal in two hours; and a portion no bigger than a walnut has been thought adequate to occasion death. Fatal accidents have occurred from it in England, France, Holland, Spain, and Corsica. The root would seem from these cases to be the most active part; but few observations are on record as to the effects of the leaves, and none as to the fruit. The root appears from these cases to be very active in all seasons, at least in the beginning of January,

the end of March, the middle of April, the middle of June, and the middle of August.

The author proceeded to inquire carefully into the effects of season upon this species as it grows wild in the neighbourhood of Edinburgh, but was surprised to find that every part of the plant in this locality is destitute of narcotic properties at all seasons. The juice of a whole pound of the tubers, the part which has proved so deadly elsewhere, had no effect when secured in the stomach of a small dog, either in the end of October when the tubers are plump and perfect, but the plant not above ground, or in the month of June when it was coming into flower; and an alcoholic extract of the leaves, and that prepared from the ripe fruit, had no effect whatever when introduced into the cellular tissue of a rabbit, under the same conditions in which the Common Hemlock acts so energetically. By a comparative experiment he ascertained that tubers, collected near Liverpool, where one of the accidents alluded to above happened in 1782, act with considerable violence on the dog; and he briefly noticed some experiments, made at his request by *Dr Pereira*, with the Œnanthe of Woolwich, shewing that there also it is a powerful poison to the lower animals. Climate seemed to the author to furnish the only adequate explanation of these extraordinary differences; yet the plant grows in all parts of Scotland with great luxuriance.

3. *Cicuta virosa*, Water-hemlock.—This species has been also held to be a deadly poison ever since an express treatise on its effects was published by Wepfer in 1716; and repeated instances of its fatal action have been observed since, and some of these very recently, in Germany. The root is the only part which has given occasion to accidents; it has proved fatal in two hours and a half. Nevertheless, this plant too seems innocuous in Scotland, or nearly so, although, like the last species, it grows with great luxuriance. The juice of a pound of the roots collected in the end of July, while the plant was in full flower, produced no narcotic symptoms; and the only effects observed, namely, efforts to vomit, might have arisen from the operation which is necessary to secure the juice in the stomach. An alcoholic extract of the leaves collected at the same time, and a similar preparation made with two ounces of the full-grown seeds, while still green and juicy, had no effect whatever when introduced into the cellular tissue of a rabbit, except that inflammation was excited where the extract was applied.

4. The author has not yet had an opportunity of trying the effects of the fourth species, *Æthusa cynapium*, or fool's-parsley.

The following Donations to the Society's Library were announced.

Journal of the Asiatic Society of Bengal. Nos. 126, 127, 128, 129, 130, and 131.—*By the Society.*

The American Journal of Science and Arts. Conducted by Professor Silliman. Vol. xliv., No. 2; and vol. xlv., Nos. 1 and 2. —*By the Editor.*

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. i. Nos. 20, 21, 24, 25.—*By the Academy.*

Proceedings of the Royal Astronomical Society. Vol. v. Nos. 30, 31, and 32.—*By the Society.*

Het Instituut of Verslagen en Mededeelingen, uitgegeven door de vier classen van het koninklijk Nederlandsche Instituut van Wetenschappen, Letterkunde en Schoone Kunsten, over den Jare 1841. Nos. 1, 2, 3, 4; and 1842, Nos. 1, 2, and 3. —*By the Institute.*

Journal of the Royal Geographical Society of London. Vol. xii. Part 2.—*By the Society.*

Historia e Memorias da Academia Real das Sciencias de Lisboa. Tomo xii. Part 2.—*By the Academy.*

Discurso lido em 22 de Janeiro de 1843 na Sessão publica da Academia Real das Sciencias de Lisboa por Joaquim José da Costa de Macedo.—*By the Academy.*

Astronomische Nachrichten. Nos. 462–477.—*By Professor Schumacher.*

Scheikundige Onderzoekingen gedaan in het Laboratorium der Utrechtsche Hoogeschool. Deel 2. St. 1.—*By the Editors.*

Tijdschrift voor Natuurlijke Geschiedenis en Physiologie. Uitgegeven door J. Van Der Hoeven M. D. en W. H. De Vriese M.D. Deel x. St. 1.—*By the Editors.*

Flora Batava. Nos. 127 and 128.—*By the King of Holland.*

Proceedings of the American Philosophical Society. Vol. ii. Nos. 24 and 25.

Transactions of the American Philosophical Society, held at Philadelphia, for promoting Useful Knowledge. Vol. viii. Parts 2 and 3.—*By the Society.*

Address to the Anniversary Meeting of the Royal Geographical Society, 22d May 1843.—*By the Society.*

Reports on the Fishes, Reptiles, and Birds of Massachusetts.—*By the Bowditch Family.*

Annales des Sciences Physiques et Naturelles, d'Agriculture et d'Industrie, publiées par la Société Royale d'Agriculture, &c. de Lyon. Tomes i. ii. iii. et iv.—*By the Society.*

Applications of the Electric Fluid to the Useful Arts, by Mr Alexander Bain; with a Vindication of his claim to be the first Inventor of the Electro-Magnetic Printing Telegraph. By John Finlaison, Esq.—*By the Society.*

The Journal of Agriculture, and the Transactions of the Highland and Agricultural Society of Scotland. July and October 1843. —*By the Society.*

Proceedings of the Zoological Society of London. Nos. 108 to 119. —*By the Society.*

Magnetische und Meteorologische Beobachtungen zu Prag. Dritter Jahrgang. Von Karl Kreil.—*By the Author.*

Journal of the Statistical Society of London. Vol. vi., Part 3.—*By the Society.*

The Transactions of the Microscopical Society of London. Vol. i. Part 1.—*By the Society.*

The Electrical Magazine, conducted by Mr Charles V. Walker. Vol. i., Nos. 1, 2.—*By the Editor.*

Proceedings of the Geological Society of London. Nos. 92–3.—*By the Society.*

Archives du Muséum d'Histoire Naturelle publiées par les Professeurs-Administrateurs de cet Etablissement. Tome ii. Livr. 3. —*By the Editors.*

Astronomical Observations made at the Royal Observatory, Edinburgh. By Thomas Henderson, F.R.S.S.L. & E., Professor of Practical Astronomy in the University of Edinburgh. For the year 1839.—*By the Royal Society, London.*

Memoirs of the Chemical Society of London. Vol. i.—*By the Society.*

Annuaire de l'Observatoire Royal de Bruxelles pour 1843, par A. Quetelet, Directeur de cet Etablissement.—*By the Author.*

Observations des Phénomènes Périodiques. Par Monsieur Quetelet. —*By the Author.*

Annuaire de l'Académie Royale des Sciences et Belles Lettres de Bruxelles pour 1843.

Nouveaux Mémoires de l'Académie Royale des Sciences et Belles Lettres de Bruxelle. Tome xvi.

Memoires Couronnés et Memoires des Savants Etrangers, publiées par

l'Académie Royales des Sciences et Belles Lettres de Bruxelles. Tome xv., Ptie 2.

Bulletin des Séances de l'Académie Royale de Bruxelles. Tome ix., Nos. 10, 11, 12, and Tome. x., Nos. 1, 2, 3, 4, 5, 6, 7.—*By the Academy.*

Journal of the Bombay Branch Royal Asiatic Society. Nos, 3, 4. January and April 1842.—*By the Society.*

Notizie relative a tre specie d'Insetti Nocivi all' ulivo dal Dr Passerini.

Osservazioni sulle Larve, Ninfe, e Abitudini della Scolia flavifrons del Dr C. Passerini.

Notizie sulla moltiplicazioni dell' uccello Americano Paroaria cucullata dal Dr Passerini.—*By the Author.*

Mémoires de la Société Géologique de France. Tome v. Pties 1, 2. —*By the Society.*

Carte Géologique du Departement de l'Aisne, exécutée et publiée sous les Auspices de M. Legrand, Sous-Secretaire d'Etat des Travaux Publics. Editée par la Société Géologique de France, 1842.—*By the Society.*

Niewe Verhandelingen der Eerste Klasse van het Koninklijk-Nederlandsche Instituut van Wetenschappen, Letterkunde en Schoone Kunsten te Amsterdam. Deel viii. Sts. 1, 2. Deel ix. Sts. 1.—*By the Institut.*

Abhandlungen der Königlichen Akademie der Wissenschaften zu Berlin 1841. Thiels 1, 2, 3.

Bericht über die zur Bekanntmachung geeigneten Verhandlungen der Konigl. Preuss. Akademie der Wissenschaften zu Berlin. Juli 1842, bis Mai 1843.—*By the Academy.*

Memoirs of the Royal Astronomical Society. Vol. xii.—*By the Society.*

Astronomical Observations made at the Royal Observatory, Greenwich, in the year 1841; under the direction of George Riddell Airy, Esq.—*By the Royal Society, London.*

Tenth Annual Report of the Royal Cornwall Polytechnic Society, 1842.—*By the Society.*

The Quarterly Journal of Meteorology and Physical Science. Edited by J. W. G. Gutch, M.R.C.S. for April 1843. No. 6.—*By the Editor.*

An Introductory Lecture on Botany, considered as a Science, and as a Branch of Medical Education. By Edward Forbes, Professor of Botany in King's College, London.—*By the Author.*

Mémoires de l'Académie Impériale des Sciences de Saint Petersbourg. (Sciences Politiques, &c.). Tome vi., Livrais 1–3.

Do. do. do. (Sciences Naturelles). Tome v., Livrais 1–. 2

Do. do. do. (Sciences Mathematiques). Tome iii., Livrais 1, 2, 3.

Do. do. do. Memoires présentés par divers Savans. Tome iv., Livrais 1.

Recueil des Actes des Séances Publiques de l'Académie Impériale des Sciences de Saint Petersbourg, tenues le 31 Decembre 1841, et le 30 Decembre 1842.—*By the Academy.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Tome xvi., No. 9–25, et Tome xvii., Nos. 1–19.—*By the Academy.*

Maps of the Irish Ordnance Survey, containing the county of Tipperary, in 93 sheets.—*By His Excellency The Lord Lieutenant.*

Transactions of the Royal Irish Academy. Vol. xix. Part 2.—*By the Academy.*

Monday, 18*th December* 1843.

Dr ABERCROMBIE, V.P., in the Chair.

The following Communications were read:—

1. A description of Congenital Malformation of the Auricle and External Meatus of both sides in three persons, with Experiments on the state of Hearing in them, and Remarks on the mode of Hearing by Conduction through the hard parts of the Head in general. By Professor Allen Thomson.

Read 18*th December* 1843, *and* 2*d January* 1844.

The three persons referred to came accidentally under the observation of the author during the past year. They were from different parts of the country, and not related to one another. In one of them only was it ascertained that other members of the same family had been similarly affected.

The first part of the paper contained a notice of the history of these persons, and an anatomical description of the malformation with which they were affected. In all the individuals, unsuccessful attempts had been made by different surgeons to uncover a mem-

brana tympani by operation. In one of them, it was supposed that a structure of that nature was brought into view, but, in the other two, nothing of that kind could be seen or felt. By a comparison of the external appearances in the last mentioned individuals, with observations made in the dissection of similar cases, and more especially from the examination of a specimen preserved in the anatomical Museum of the University of Edinburgh, the author formed the conclusion, that, in the majority of such cases, the complete closure of the bony part of the meatus opposes an insuperable obstacle to their relief by surgical operation; and that the malformation visible externally, indicates the existence of other defects in the deeper or middle portion of the organ of hearing. These defects consist in the small size and unnatural shape and structure of the cavity of the tympanum; the imperfect condition of the chain of small bones; the impossibility of these bones fulfilling their usual office from the absence of their connection with a membrana tympani; and probably other defects of structure, such as that observed in the specimen preserved in the Edinburgh Museum, which seems important, as consisting in a contracted state of the fenestra rotunda, and the want of direct communication of that orifice with the cavity of the tympanum, such, in fact, as would occasion an interruption of the transmission of vibrations through the air of the tympanum to the fluid of the labyrinth. It does not appear probable, that the Eustachian tube is entirely absent in such cases; but the size of its opening into the tympanum is probably much diminished in most of them. In most of such cases, the labyrinth or internal ear appears to be natural. The defective condition of the bony parts in these cases then appears to consist mainly in the absence of a part of the tympanic bone, that, namely, which intervenes between the fissure of Glaser and the mastoid process, and which forms the tympanic ring and auditory process of the temporal bone.

In the second part of the paper, the author endeavoured to explain the origin of the malformation in question, by a reference to the ascertained history of the development of the external and middle parts of the organ of hearing in the fœtus of man and animals: founding his conclusions more particularly upon the researches of Huschke, Rathke, Reichert, Günther, and his own observations in this point of organo-genesis. From these, it appeared that malformations of the external and middle ear are, in a great measure, unconnected in their origin or progress with those of the labyrinth; and that, while the latter are related to the earliest changes of for-

mation occurring in the brain and cranium, the former may be traced to an arrest or imperfection in the development of part of the walls of the visceral cavity, more particularly of the two anterior branchial arches and the fissure between them. The incomplete condition of the chain of ossicula, and part of the bony wall of the tympanum, is attributable mainly to the defective development of the first branchial arch; the want of the tympanic ring and auditory process, and the consequent absence of bony meatus, to the deficient development of the second branchial arch. The same observations rendered it probable, that the closed condition of the meatus proceeds from a preternatural increase of that deposit in the outer part of the first branchial fissure, which, in the course of natural development, forms the foundation of the septum of the membrana tympani, and thus separates the cavity of the tympanum and Eustachian tube on the inside from the meatus on the outside of this the first branchial fissure. The malformation of the softer part of the meatus externus, and of the auricle, is connected with a defect in the development of the integumental parts of the first and second branchial arches, which constitutes the latest series of changes occurring in the parts under consideration, and, accordingly, is more frequently defective than the others. The very peculiar form of the face, resulting from the undeveloped condition of its maxillary, zygomatic, and malar portions, together with the existence of cleft palate, to a slight degree, in two of the individuals described, appeared to the author to establish still more fully the relation subsisting between the origin of the malformation of the auricle, meatus, and tympanum, and the incomplete development of the anterior part of the transitory branchial apparatus of the fœtus.

The third part of the paper contained an account of a series of experiments performed on the state of hearing in the malformed individuals, and in other persons having the external meatus artificially plugged. In all the three malformed individuals, the hearing was such that they could carry on a conversation with others who spoke slowly and articulately to them, and in one only was there any degree of difficulty in this; and yet, in all of them, sounds must have been communicated to the ear entirely through the bones of the head. In ordinary persons, it is well known, that all sounds which are transmitted directly by contact of the sounding body with the hard parts of the head, are heard with greater intensity when the external ears are closed; but in them the most complete plugging or obliteration of the meatus does not reduce the ear to the condition of that organ

in an aquatic animal, nor entirely remove the effect of the chain of bones and column of air within the tympanum. The author shewed, that in two, at least, of the three malformed individuals, the case was different, as circumstances existed which obstructed the secondary action both of the chain of bones and tympanic column of air, so that these two individuals might be regarded as hearing solely through the solid parts of the head. In these two individuals it was ascertained, by accurate and frequently-repeated experiments, that hearing was not, as in other persons, most perfect near the site of the ear, but on the top of the head; and this was the case whether the sounds proceeded from a body held in contact with the head, or at some distance in the air. So exclusively, indeed, did the hearing seem to take place in these two individuals through the hard parts of the head, that neither, but particularly one of them, seemed ever to have referred sounds to the ear as the seat of the sensation of hearing. As might be supposed in such circumstances, these persons made no distinction between hearing in one ear and in the other; and could obtain, therefore, no knowledge of the direction of sounds in the same manner as other people do, by the comparison of the relative intensity of sounds in the two ears, or in the same ear in different positions. The author made some remarks on the amount of deafness which is calculated to induce dumbness, as well as upon the means of distinguishing different kinds of deafness, and the different means that ought to be employed for their relief. He concluded his paper with some remarks upon the subject of double hearing, considered with reference to the obvious impossibility, in the individuals referred to, of the sensations of one ear being distinguished from those of the other, in consequence of the perfectly equal and simultaneous communication of sonorous vibrations to both ears.

2. On the Luminousness of the Sea. By Dr Traill.

The author stated, that this phenomenon seems scarcely to be noticed in the writings of Aristotle or of Pliny which have reached us, though Pliny was familiar with the light emitted by certain shell-fish, and by the *Sea Lung* or Medusa.

Mr Boyle gives an account, from the journal of a shipmaster, of the luminousness of the sea; and it is particularly detailed, from personal observation, in the Indian voyage of Father Bourzes, in 1704.

The first philosophers, who ascribed it to light emitted by living animals, would seem to be the Abbé Nollet, Professor Vianelli, and Dr Gressellini of Venice, about the middle of the last century. In Cook's first voyage, the luminous properties of several marine animals

are well described by Banks and Solander; and in his second voyage, by Forster. Spallanzani made some good experiments on the phosphorescence of a Medusa in the straits of Messina.

Since that period, the catalogue of noctilucous animals has been greatly enlarged, especially by Peron and Lessueur, the naturalists to the French Voyages de Découvertes aux Terres Australes. A good paper on the luminousness of the sea, by Mr Macartney, appeared in the London Phil. Trans. for 1810; in which the phenomenon is ascribed entirely to living animals, an opinion now generally embraced by naturalists.

The author then detailed his own experiments and observations made, from early life, in different parts of the European Atlantic, from lat. 62° to 36° N. chiefly around the shores of Britain, all which confirmed this opinion.

He detected, in 1814, several of the same noctilucous animals in the waters of the Bay of Biscay as in our own seas, especially the *Noctiluca miliaris*, *Orythia minima*, and a very minute crustacean, seemingly a Zöe.

Besides these, the *Beröe fulgens* of Macartney, and several other Medusaria, he found two very remarkable animals in the luminous waters of the seas around the Western Isles of Scotland—one an *Æquorea*, most splendidly phosphorescent, which seems to be *Æquorea mesonema* of Eschscheltz; and the other a most elegant *Cydippe*, probably the *Cydippe pomiformis* of Paterson. Both were carefully figured from the life by the author, and magnified drawings of them were exhibited.

The paper was concluded by some strictures on the hypothesis of Lamarck, respecting the absence of muscular power and of voluntary movements in the order of *Radiaires mollasses*. He gave the results of many experiments which he had made on the movements of the Medusæ, and which convinced him that they possessed considerable muscular power, obedient to volition; and he ascribed the erroneous views of Lamarck on this subject to his little familiarity with those animals in their natural haunts; for a Medusa swimming in the sea, and cast on the beach, have very different capabilities of locomotion.

The following Donations to the Society's Library were announced.

Journal of the Asiatic Society of Bengal. Nos. 132 and 133.—*By the Society.*

Proceedings of the American Philosophical Society. Nos. 26 and 27.—*By the Society.*

Tuesday, *2d January* 1844.

Dr ABERCROMBIE, V.P., in the Chair.

The following communications were read:—

1. On the Fossil Vegetables of the Sandstone of Ayrshire, illustrative of a series of them, as a Donation for the Society's Museum. By J. Shedden Patrick, F.R.S.E., F.R.S.S.A., &c.

The author, after mentioning that they were collected by himself from a quarry on the estate of Mr Warner of Ardeer, in the parish of Stevenston and district of Cuninghame, shortly described the quarry, as belonging in its geological position to the carboniferous group; and stated that it is considered the most valuable for white freestone in the west of Scotland. He mentioned the different strata in the order of their occurrence; and stated that coal had been wrought out from beneath it, within the remembrance of the present generation. He said that the fossils are not confined to any one stratum of the sandstone, but are found in them all, wherever the stone is faulty. He had counted about five strata at the deepest part of the quarry, separated from each other by thin layers of shale; and fossils are found in all these strata, chiefly, however, where the sandstone is rendered impure by a mixture of greenstone and ironstone. There have been above thirty different kinds of fossils found in this quarry (and in the schist connected with the coal); among them many beautiful impressions of *Stigmariæ*, *Sigillariæ*, *Lepidodendra*, and other plants unknown in the present day. Among the ferns will be found *Sphenopteris*, *Neuropteris*, *Pecopteris*, &c. The fossils which occur in greatest profusion are the *Calamites*. Of these, the two kinds met with most commonly are *Calamites nodosus* and *C. approximatus*. The following species are also found, but not so frequently, *C. cannæformis*, *C. Mougeotii*, *C. arenæceus*, and *C. verticillatus*.

The *Sternbergia approximata*, designated by Lindley "a most singular coal-measure plant occurring in most coal-fields in Great Britain, but not abundant anywhere," is likewise found here; the specimens obtained are in general small, but one or two fine large ones have been got. They are usually found in the sandstone, and are covered with a fine coal, which adheres either in the form of an even, thick, glossy integument, or in a powdery state, to the surface of the stem. Some very fine examples of *Sternbergia nodosa* have likewise been procured.

A curious fossil, which he has every reason to believe is original—was discovered by the author among the debris of the quarry. It somewhat resembles a piece of tartan, being divided into regular parallelograms, by double lines intersecting each other at right angles. He submitted it to the inspection of the Rev. D. Landsborough, and to other gentlemen in the neighbourhood, who all declared that it was new to them. He also shewed it to the manager of the works, and to some of the most intelligent of the overseers and colliers, and they all said that they had not before met with it; he therefore ventures to think it unique. Mr Landsborough, after minute examination, bestowed upon it the name of *Dictyodendron Patricii*, deriving the generic name from δικτυον, a net, from its close resemblance to net-work, and δενδρον, a tree; and dedicating it, by the specific name, to the author, as its discoverer.

The Stigmariæ, which may be said to be peculiar to, and the distinguishing feature of, the coal-measures, occur plentifully. Among these will be found *Stigmaria ficoides*, *S. radiata* and *Stigmaria*. Brongniart comes to the conclusion that the *Stigmaria* and *Sigillaria* constitute a peculiar and extinct family (belonging probably to the gymnospermous division of the Dicotyledons), but of which neither the fruit nor the leaves are as yet known, and adds, that probably *Stigmaria* is only the root of *Sigillaria*.

The *Trigonocarpum olivæformæ* (or fruit of the palm) is very scarce, being found only in one portion of the quarry, of very small extent, in the lowest stratum, next to the shale.

Another fossil met with, but rare, in that district at least, is *Halonia tuberculata*. A very fine specimen was obtained some time ago, adhering to the surface of the upper stratum of sandstone.

Of the *Lepidodendra* there are several species; among them *Lepidodendron Sternbergii* and *L. Harcourtii*, and a peculiar and rare variety, with whose specific name the author is unacquainted.

Eudogenites striata is also met with.

A very remarkable fossil was discovered in 1842, by the Rev. D. Landsborough, which there is every reason to consider as unique. He says, that only a very few specimens exist, and that, to the best of his belief, it has not been found elsewhere. He submitted it to the Philosophical Society of Glasgow, who report, that "the exposed surface presents a most singular appearance, and is unlike any fossil plant which we have ever seen figured. Its peculiar appearance is its resemblance to part of a common osier-basket. Hence, Mr L. used humorously to designate it 'Noah's creel,' for want of a better name. To supply this

desideratum in nomenclature, and as no such fossil appears to have been described or figured, we have named it '*Lyginodendron Landsburgii*;' forming the generic name from λυγινος, wicker-work, and δενδρον, a tree; and dedicating it by, its specific name, to its discoverer, Mr Landsborough." The fragments of the fossil were spread over a space of about two yards, and have not been observed, except in that place. The finest specimen obtained was about 18 inches in length, by 3 in breadth. It was discovered in the middle stratum.

Of the genus *Sigillaria* there are two or three varieties, as *Sigillaria oculata*, *Sigillaria reniformis*, &c. &c.

The most magnificent fossil found in the quarry is the *Bothrodendron punctatum*. A splendid specimen of this fossil is in the possession of Mr Landsborough, which he describes to be of a size and weight which he can scarcely lift from the ground. It is extremely rare, however; only two, or at most three, examples of it have been procured.

Another very curious and remarkable fossil also, is the *Stylolithen*, of which there appears to be two distinct varieties—one with very broad stripes, the other with the lines more closely approximating, and, likewise, more deeply indented.

Specimens of all the before-mentioned fossils were contained in the collection presented to the Society. The author presented at the same time some masses of impure ironstone, from a coal-pit on the same estate, containing very beautiful specimens of the *Unio Urii*.

2. On a new Self-Registering Barometer. By Robert Bryson, F.R.S.

From the nature of the instrument, it is impossible to give an intelligible abstract of the paper. The paper, with a description of the instrument, and a statement of its indications for some months, is published in the Society's Transactions.

Monday, 15*th January* 1844.

Dr ABERCROMBIE, V.P., in the Chair.

The following Communications were read:—

1. On the Vibrations of an Interrupted Medium. By Professor Kelland.

The object of this paper was the approximate determination of the change of phase, and intensity of a ray reflected at the surface of a medium, which admits of no refraction.

2. On certain Laws of the Resistance of Fluids. By John Scott Russell, Esq.

3. Chemical Examination of the Tagua-Nut, or Vegetable Ivory. By Professor Connell.

This remarkable nut is now well known as being extensively carved into ornaments, having the high polish and general appearance of the finest ivory.

It is a seed or nut of a palm called *Phytelephas macrocarpa*, which is found on the banks of the Magdalena river, in the republic of Columbia.

For analysis the fine turnings of the vegetable ivory were employed. These were well rubbed in a mortar successively with cold and hot water, and were then heated with hot alcohol. The constituents were found to be—

Gum,	6.73
Legumin or Vegetable Casein,	3.8
Vegetable Albumen,	0.41
Fixed Oil,	0.73
Ashes,	0.61
Water,	9.37
Lignin or Woody Matter,	81·34
	100.

In the ashes were found phosphate of lime, sulphate of potash, chloride of potassium, carbonate of lime, and a little siliceous matter.

The following Donations to the Society's Museum were announced:—

14 Specimens of British land and fresh-water Shells. Presented by the Honourable Mrs MACADAM CATHCART.

Block of Sandstone, with organic remains imbedded in it, found in one of the dry docks at Leith, when enlarging it; originally from Rosyth Quarry, Fifeshire. Presented by Captain PATRICK DALL, R.N.

Portrait of James Mitchell, at the age of 46 years, well known, and described in the Transactions of this Society, by the late Professor Dugald Stewart and others, as the blind, deaf, and dumb boy. This portrait was given by his sister, Jane G. Mitchell, to, and was presented by, Sir THOMAS DICK LAUDER, Bart.

The following Donations to the Society's Library were announced.

Proceedings of the Geological Society of London. Nos. 94, 95, and 96.—*By the Society.*

Journal of the Statistical Society of London. Vol. vi. pt. 4.—*By the Society.*

Journal of the Asiatic Society of Bengal. Nos. 50, 51, and 52.—*By the Society.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences de Paris. Tome xvii., Nos. 20, 21, 22, 23, and 24. —*By the Academy.*

The Journal of Agriculture, and the Transactions of the Highland and Agricultural Society of Scotland. Jan. 1844.—*By the Society.*

Elements of Agricultural Chemistry and Geology. By James F. W. Johnston, M.A., F.R.SS.L. & E., &c.—*By the Author.*

Transactions of the Institution of Civil Engineers. Vol. iii., pts. 2, 3, 4, and 5.

Minutes of Proceedings of the Institution of Civil Engineers for Sessions 1840–41–42–43.—*By the Institution.*

Flora Batava. Nos. 129 and 130.—*By the King of Holland.*

Descriptive Catalogue of the Anatomical and Pathological Museum of the School of Medicine, Park Street, Dublin. By John Houston, M.D.—*By the Author.*

Transactions of the Society instituted at London for the encouragement of Arts, Manufactures, and Commerce. Vol. liv.—*By the Society.*

The Journal of the Royal Asiatic Society of Great Britain and Ireland. No. xiv.—*By the Society.*

Tijdschrift voor Natuurlijke Geschiedenis en Physiologie. Uitgegeven door J. van der Hoeven, M.D., en W. H. De Vriese, M.D. Deel x., Stuk. 4.—*By the Editors.*

Abhandlungen der Königlichen Gesellschaft der Wissenschaften zu Gottingen. Band 1.—*By the Society.*

Nova Acta Academiæ Cæsareæ Leopoldino-Carolinæ Naturæ Curiosorum. Vol. xviii., Suppl. ii., et Vol. xix., Pars. ii.—*By the Academy.*

Almanach der Königlichen bayerischen Akademie der Wissenschaften. 1843.—*By the Academy.*

Twenty-third Report of the Council of the Leeds Philosophical and Literary Society. 1842–43.—*By the Society.*

Bulletin de la Société Impériale des Naturalistes de Moscow. 1842, No. 4, et 1843, Nos. 1, 2, 3.—*By the Society.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

1844. No. 24.

Elections omitted in No. 23.

18*th February* 1843.

Arthur Forbes, Esq. of Culloden.
J. Burn Murdoch, Esq.

Monday, 2*d January* 1844.

The Hon. Lord Murray.

Monday, 5*th February* 1844.

Sir T. M. BRISBANE, Bart., President, in the Chair.

The following communications were read:—

1. On the Tides of the Firth of Forth, and the East Coast of Scotland. By J. S. Russell, Esq. (Abstract of this paper not obtained from the author.)

2. Additional Observations as to the Poisonous Properties of Œnanthe crocata. By Dr Christison.

In this paper the Author added a few supplementary observations to those made on the alleged poisonous properties of the *Œnanthe crocata*, in his paper on the poisonous *Umbelliferæ*, read on the 4th December last.

He stated that he had met with other cases of poisoning with this plant, recorded by Continental authors, shewing that death may take place in an hour,—that so small a quantity as a single tuber, no

bigger than the finger, has proved fatal,—that the roots are poisonous in some countries, from the beginning of January till the middle of October at all events, and probably throughout the whole year ; and that Spain may be added to the countries formerly mentioned, where fatal effects have been produced by the plant.

He next added, that he had recently tried on a dog the effects of the juice of a pound of tubers, collected by Dr Pereira on the 16th December from the locality at Woolwich ; and that no effect, or an exceeding slight one only, was produced.

It was farther observed, that, according to an analysis executed in 1830 by MM. Pihan-Dufeilay and Cormerais, the activity of the roots in French plants depends upon a resin. On proceeding to try upon a rabbit the effects of the resin, obtained by their process from the Woolwich plants, the author found that, when the resin from eight ounces avoirdupois, amounting to 24 grains, was introduced in the state of emulsion into the cellular tissue, the animal died in 78 minutes, after being affected with a remarkable combination of tetanic spasm and convulsions: but that no effect whatever was produced by the resinous extract from the same quantity of roots obtained about the same season of the year (midwinter) from the Dalmeny œnanthe, near Edinburgh,

He concluded this notice with an account of some experiments on the chemical analysis of œnanthe, observing that he had failed to obtain any principle from the Dalmeny seeds or root, by a process analogous to that by which conia is obtained from hemlock; and that the alcoholic extract of the Woolwich plants, distilled with solution of potash, yielded, like hemlock, a little oleaginous-like fluid, which was too minute in quantity for him to ascertain its properties accurately, but which on the whole seemed a volatile oil, and not an alkaloid.

Lieut.-Colonel Lowe was duly elected an Ordinary Fellow.

Monday, 19*th February* 1844.

Dr ABERCROMBIE, V. P., in the Chair.

The following communications were read :—

1. On the Cellular Fibre and the Incrusting Matters of Plants. By Mr P. F. H. Fromberg. Communicated by Professor Johnston.

The results obtained by the author, on analysing the cellular

fibre of different kinds of plants, after a sufficient purification, are, on the whole, in conformity with those of Payen. But he considers the formula, which Payen has derived from his results, an inconvenient one; and that the composition of cellular fibre is in conformity with that of inuline, rather than with that of starch, as that chemist has supposed.

The author observes that he obtained, by treating different kinds of wood in different ways, a great many substances, of different properties and composition. As to the composition, however, it could almost always be represented by a formula, differing, more or less, from that of ulmic acid, only by the number of equivalents of hydrogen, that of the carbon and oxygen remaining the same. The composition of the ulmic acid is, according to numerous and accurate experiments of Professor Mulder, $C^{40} H^{14} O^{12} +$, a greater or less number of equivalents of water, according to the temperature at which the substances are dried, and the manner in which they are obtained.

Now, according to the analysis of several kinds of wood, and especially of the more constant, hard perisperm of the stone fruits analysed by M. von Baumhauer, the following formula is determined :—

	Found.	Atoms.	Calculated.
Carbon,	52.5	64	52.38
Hydrogen,	5.9	44	5.88
Oxygen,	41.6	39	41.74
	100		100

If we subtract from this formula . . $C^{64} H^{44} O^{39}$

That of the cellular fibre, . . . $C^{24} H^{21} O^{21}$

There remains, ... $C^{40} H^{23} O^{18}$

As the average formula of all kinds of incrusting matters, which may be easily reduced to this :—

$$C^{40} H^{17} O^{12} + 6 H O,$$

A combination which differs from ulmic acid only by three equivalents of hydrogen.

All the matters obtained and analysed by the author, could be represented by formulæ from $C^{40} H^{22} O^{12}$ to $C^{40} H^{14} O^{12}$, all the others containing 20, 21, 19, *etc.* of hydrogen. The last formula, $C^{40} H^{14} O^{12}$ + water, which is at the same time that of ulmic acid, represented a substance obtained after the action of strong reagents.

In all these experiments, an augmentation of carbon was accompanied by a diminution of hydrogen; but the proportion of the change varied.

According to the author's experiments, so far as they have gone, cellular fibre is not only soluble in alkalies, but also gradually changed by them into matters which approach, more and more, to the composition and properties of the ulmic acid. The difference between the action of alkalies and of acids consists in this: that the states of transition, namely dextrine and sugar, are not produced by the action of the alkalies. Cellular fibre and the incrusting matters, when united in the substance of the plant, resist more powerfully the influence of chemical reagents, than when they are separated from each other. Payen's idea, that the incrusting matters should be considered as consisting of three substances, two of which are electro-negative, seems much too limited and artificial.

The quantity of nitrogen found in these substances was much too small to exercise any influence on the composition. It is the younger parts of growing plants to which nitrogen is indispensable, and in which it can always be found and demonstrated.

Finally, it is not improbable that there exists a whole series of incrusting matters, always present in their substance, for the use of the different fluids and organs of plants: a purpose for which they are eminently calculated, by their great facility of transformation, and by their strong tendency to attract water.

Were we to assume the transitory existence of ulmic acid in the cells, we should probably obtain wider ideas with regard to the growth and decay of plants. It is well known, with respect to the decay of vegetable matter, that a large quantity of hydrogen must be set free during its decomposition, by means of which the formation of ammonia in the soil is eminently favoured.

In the converse process, that of growth, precisely the opposite process—that is, combination with hydrogen—must occur. Growth is thus a reduction, decay an oxidation. The ulmic acid would thus be, after the formation of the primary cell fibres, the common source of all the matters deposited in the cells, in all plants which are rooted in the ground.

If we agree to this proposition, then we do not require the decomposition of water to explain the growth of plants. The large quantity of pectine, $C^{12} H^{8} O^{10}$, which is present in some parts of so many plants, and which may be considered as the incrusting matter of the cells of carrots, turnips, different kinds of fruits, &c.

together with other organic matters which contain much oxygen—for instance, oxalic acid—may be the cause of the relative and various abundance of hydrogen in the products of ulmic acid—namely, the incrusting matters of plants.

2. On a remarkable Oscillation of the Sea observed at various places on the coasts of Great Britain, in the first week of July 1843. By David Milne, Esq.

This phenomenon was observed on the 5th July and three following days. It did not occur on all parts of the coasts of Great Britain. In England, it was observed only on the south shores of Cornwall and Devonshire. In Scotland, it was observed on the east coast; and there it was seen at a great many places, between Eyemouth in Berwickshire and the Shetland Islands.

It was only on the 5th July that the oscillation occurred on the Cornish and Devonshire coasts. It prevailed on the Scottish coast, however, from the 5th to the 7th July inclusive.

The phenomenon consisted of a flux and reflux of the sea, beyond what could be accounted for by ordinary tides, or any wind prevailing at the time. The water suddenly rose up and sunk down from 2 to 5 feet in perpendicular height, producing effects more or less striking, according to the shelving character of the shore.

In regard to the cause of the phenomenon, various had been the surmises; though the general impression seemed to be, that it was produced by distant submarine earthquakes.

The author stated that he could not acquiesce in this view, and gave his reasons for saying so.

In order to obtain a wider field of induction, he referred to former instances of oceanic oscillations, and shewed that they were almost always accompanied with considerable atmospheric disturbances.

He then proceeded to give an account of a remarkable storm of wind, accompanied by thunder, lightning, and hail, which had traversed the British Islands on the 5th July, appearing first in the SW. of England, and passing through the midland counties, traversing the south-east parts of Scotland, and going off about the Aberdeenshire coast.

By the lightning and large hail-stones accompanying this storm, much damage to property, as well as loss of life, had occurred. At Sheffield, the barometer was, during the passage of the storm, observed to sink suddenly about an inch.

The storm appeared to have rotated, and in the usual way,—viz. in a direction contrary to that of the hands of a watch,—of which proofs were given.

The author then suggested, that the oscillations in question were probably produced by this storm. The parts of the coast where they were observed, coincided with the direction in which the storm moved. The fact that the oscillations on the Cornish and Devonshire coasts commenced before the storm arrived there, so far from being hostile to, supported this view; for if waves were created by the storm, as it approached Great Britain, these waves would advance more rapidly than the storm, which appeared to move northwards at the rate of from 70 to 80 miles per hour,—whereas the similar waves produced by the two Lisbon earthquakes had moved forward at a rate of from 120 to 130 miles per hour.

As to the way in which waves could be produced on the surface of the ocean, sufficient to produce the fluxes and refluxes in question, it was observed—

(1.) That the wind, by its mere mechanical pressure, was capable of heaping up, over a large expanse, a considerable body of water. By the force of the south or south-west blasts in the storm, the sea would be elevated, and waves would thereby be formed, which would move forward before the storm towards the south coast of England.

(2.) That the level of the ocean rises in proportion to the fall of the barometer; so that if, as there was every reason to suppose, this storm was accompanied in its track by a diminution of atmospherical weight, waves almost commensurate in extent with the diameter of the storm would be formed.

In either or in both of these ways, the sea may have been, and probably was, so affected on the 5th, 6th, and 7th July 1843, as to produce the ebbing and flowing which was observed on certain parts of the coasts of Great Britain.

The following Gentlemen were duly elected Ordinary Fellows:

Archibald Swinton, Esq., Professor of Civil Law in the University of Edinburgh.

Dr Begbie, Fel. Roy. Col. Surg. Edin.

The following Donations of Books to the Society's Library were announced:—

The London University Calendar for 1844.

The Examination Papers of the London University for the year 1844.—*By the Council of the University.*

The Transactions of the Linnæan Society of London. Vol. xix. Part 2.

Proceedings of the Linnæan Society of London. Nos. 15, 16, 17, 18.—*By the Society.*

Astronomical Observations made at the Radcliffe Observatory, Oxford, in 1840 and 1841. 2 vols. By Manuel J. Johnson, —*By the Radcliffe Trustees.*

Maps of the Irish Ordnance Survey, containing the county of Dublin, in 30 sheets.—*By the Lord Lieutenant.*

Nouveaux Mémoires de la Société Impériale des Naturalistes de Moscow. Tome vii.—*By the Society.*

Monday, 4th March 1844.

Sir T. M. BRISBANE, President, Bart., in the Chair.

The following communication was read:—

On the Human Races in Britain, enumerated by Tacitus. By Dr Hibbert Ware.

This memoir had been undertaken as preliminary to an ethnological inquiry which the author had proposed to institute into the aborigines of the British Islands. It was premised, that, in this endeavour to seek for ancient races in those which were modern, great caution is required.

It has been asked, if, at the present day, we can as readily distinguish an Iberian type from one that is Gaulish or Caledonian, as was done more than seventeen hundred years ago in the time of Tacitus? It is answered, that, by a conservative principle in our nature, directed to the persistency of types, the influences of Time, Climate, and Civilization, are rendered of little avail. And, even in a mixture or crossing of races, there is an interposition of preserving laws made in favour of mutually approximating types, such as those of Europe. For instance, when two or more races are mingled together in different proportions, it is expected that the type of the minority will eventually become merged in that of the majority. But whether, in accelerating or postponing such a result, it will be found that, among all animals, nature exercises a sort of discretionary power under three varied circumstances: 1*st*, When races widely differ from each other; 2*d*, When races are in a less degree remote; and,

3d, When races, like those of Britain, or Europe in general, approximate closely to each other. These three circumstances the author discussed in succession.

1st, When races widely differ from each other, as in the crossing of the horse and the ass. In this case, nature has ever declared, that a debased or intermediate breed shall not be perpetuated.

2d, When races are in a less degree remote. In this example nature acts with uniformity, as in the crossing of the spaniel with the greyhound, &c.; and, among the human species, in the mixture of European and black races. In any one of these instances, there is no incapacity in the progeny to perpetuate its breed; but it will be found that the principle directed to the persistence of races gradually restores, in the course of a few generations, the purity of any one of the types which may have been contaminated by mixture, while the other type, in the meantime, is doomed to extinction.

3d, When races approximate closely to each other, as when spaniels (of which there are divers breeds), are crossed among themselves, and the same of white and grey mice, the result shews that, in the progeny, the types of a paternal or maternal stock are less liable to occur in an intermediate, than in a perfectly distinct form; or, in other words, that there is a less tendency to a fusion than to a separation of types. For instance, in the Western Highlands of Scotland, which were peopled in succession by the dark-haired Gael, and the flaxen-haired Scandinavian, there is, in the descendants, less a mixture than a separation of the types; the progeny of many families of the peasantry illustrating the distinctness with which Gaelic and Scandinavian characters are reproduced in cases where the paternal and maternal types differ from each other.

In bringing forward these illustrations, it was far from being argued that a progeny did not often exhibit an intermediate character, derived from the two races of a paternal and maternal stock; it was simply urged that a separation of types is equally, if not more common; and that, when a sort of intermediate character is actually derived from two European races, it is not necessarily perpetuated to a future progeny. On the contrary, a pure and distinct type, even though rendered, for a generation or two, intermediate and obscure, is often revived, with all its primitive decision of character.

The author, lastly, availed himself of the occasion to state, that the laws which appertained to the characters of races, hold good also with *individual* distinctions; and that nature seemed far more intent

upon perpetuating through successive generations, what might be named the type of the *individual*, or *person*, than upon producing intermediate likenesses, referred (often fancifully) to two types, paternal and maternal.

From all these observations, it was concluded, that, although in every society of mixed races the type of the minority had a tendency to become merged, or to disappear in that of the majority, yet that, by the interposition of relaxed laws, made in favour of the mixture of two or more approximating races, such a result (in the absence of exterminating wars, famine, or pestilence) may be postponed to an incalculable period of time; and, as an ultimate consequence, that the discovery of ancient European races in those which are modern is a reasonable expectation not likely to be frustrated.

After these observations, the author proceeded to the chief object of the Memoir, which was to explain, on ethnological principles, the ancient British races enumerated by Tacitus. These were, 1*st*, the Caledonians—" the red hair of those who inhabit Caledonia, and their large limbs, bespeak a German origin;" 2*d*, the Gauls—" those who are nearest to the Gauls are also similar to them;" and, 3*d*, the Iberians, indicated by their swarthy features and their curled hair.

The following exhibits a classification of the modern British races with which the author compared those enumerated by Tacitus; but the description of them does not admit of abridgment.

(A.) RACES REFERRIBLE TO THE LIGHT-HAIRED GERMAN STOCK.

Under the common title *German*, it was supposed that three races, and possibly a fourth, might be included.

(*a*) *The Teutonic race.*—To this race the description given of the Germans by Tacitus was supposed to apply exclusively. This type the author stated to be found in Scotland and the north of England.

(*b*) *The Scandinavian race.*—This type was described by the author as it occurs in Orkney and Shetland, in the North and West Highlands of Scotland, and in Ireland.

(*c*) *The Anglo-Frisian race.*—The type prevails in the south and midland districts of England, but diminishes in the northern counties and in Scotland.

(*d*.) *The Pictish race.*—The author has not yet had leisure to verify his suspicion, that there exists, in certain Scottish districts,

another German race, to which, possibly, the description given of the Picts by Adamnan and various early writers, may apply.

(B.) The Dark-haired Races of Europe.

Between the light-haired and dark-haired races of Europe constitutional differences exist; the former shewing the sanguine, and the latter the melancholic temperament. In the female constitution the diversity is still more apparent. Under the dark-haired races are included (*a*) the Cymric; (*b*) the Gaulish; (*c*) the Iberian. Tacitus merely distinguishes the two latter; but under the term Galli of the ancients, two distinct races are included; and when the Romans alluded to the gigantic stature of the Gauls, the description could only apply to the Cymric race, variously named Cimmerii, Cimbri, and Ombri, who were contemporary with the Gauls.

(*a*) *The Cymric race.*—This was the type of the ancient Britons in the time of Tacitus, as well as of the Belgæ and Armorici in Gaul. It was also that of the Fir-bolgs (Viri Bolgæ) of Ireland.

(*b*) *The Gaulish or Gallic race;* also named Celtic,—a name which M. Thierry has proved to be merely a local one applied to an armed confederation of Gauls. The type was that of a third part of Gaul; and, in the time of Tacitus, it distinguished the population of Ireland, part of Wales, and perhaps a few limited districts of Caledonia.

(*c*) *The Iberian race.*—This type is still to be studied in the ancient Silurian district of Tacitus, particularly in the counties of Monmouth and Brecon. Hitherto the characters of this race have not been defined; which blank in ethnology it was one of the leading objects of the present memoir to supply;—while another, yet an ultimate one, was to shew, that the Iberian tribes are to be considered as the aborigines of the British Islands, as well as of Spain, Ireland, Gaul, and Italy.

The following Donations of Books to the Society's Library were announced:—

Annuaire Magnétique et Météorologique du Corps des Ingénieurs des Mines de Russie, Par A. T. Kupffner. Année 1841.—*Par le Ministre des Finances.*

Journal of Agriculture, and Transactions of the Highland and Agricultural Society of Scotland, March 1844.—*By the Society.*

Observations on Days of unusual Magnetic Disturbance made at the

British Colonial Observatories, under the Departments of the Ordnance and Admiralty. Printed by the British Government, under the superintendence of Lieutenant-Colonel Sabine, of the Royal Artillery. Part 1. 1840–1841.—*By the Master-General of the Ordnance.*

Monday, 18th March 1844.

Dr ABERCROMBIE, V.P., in the Chair.

The following communications were read:—

1. On the Existence of an Osseous Structure in the Vertebral Column of Cartilaginous Fishes. By James Stark, M.D., F.R.S.E.

The author, after quoting from the works of writers on Ichthyology and Comparative Anatomy their descriptions of the vertebral columns of cartilaginous fishes, proceeded to point out the existence of an osseous structure in the vertebræ of the Plagiastomi, or Rays and Sharks. In these animals the essential portion of each vertebra consists of a double cup or saucer-shaped osseous piece, resembling in form and structure the double cup-shaped vertebræ of osseous fishes, being, like them, composed of concentric rings of osseous matter. It was shewn that the whole of the encrusting cartilaginous matter, with its calcareous granules, could be removed from this osseous structure, without affecting the integrity of the spinal column, or interfering with the intervertebral ligamentary apparatus which was alone attached to this osseous structure. These double cup or saucer-shaped vertebræ were in the Rays shewn to be perforated by an extremely minute central aperture, which was, however, of a considerably larger size in a few genera of Sharks, as in the Dog-fish; while in others, as in the Saw-fish, no such aperture could be distinguished.

These double cup or saucer-shaped vertebræ receive various strengthening columns, pillars, or plates of osseous matter, which differ in structure and disposition in the several genera and species of cartilaginous fishes. In some, these plates were shewn to have a concentric arrangement, and to be separated from each other by plates of cartilage. In others, the plates were broad and flat, and extended only from the margin of the one cup to that of the other cup of the same vertebra. In others, the supports were compound and broad

and had a somewhat radiated arrangement from the centre to the circumference. While in others, two of these modes were united in strengthening the osseous cups.

The peculiarities of these double osseous cups, and their supporting columns, were pointed out in the vertebræ of the Common Skate (Raia batis), Thornback Ray (R. clavata), Sharp-nosed Ray (R. oxyrhynchus), Starry Ray (R. radiata), Common Dog-fish (Scyllium Catulus), Spotted Dog-fish (S. canicula), Picked Dog-fish (Spinax acanthias), Common Tope (Galeus vulgaris), Basking Shark (Selache maximus), White Shark (Carcharias vulgaris), Saw-fish (Pristis antiquorum), and Chimæra (Chimæra monstrosa).

The vertebral column of the Sturiones and Cyclostomi was shewn to be essentially composed of soft transparent cartilage.

It was demonstrated by a chemical analysis of the essential osseous portions of the vertebræ, that they were true bone. This was evidenced by their containing the same amount of earthy and animal matters, as the bones of osseous fishes, as well as by their earthy salts being of the same nature in both classes of bones. The result of the author's analysis gives, as a mean, about 69 per cent. of earthy matters, chiefly consisting of phosphate of lime, and 31 per cent. of cartilage. The chemical composition of the common cartilaginous skeleton, and of the vertebræ, with their encrusting cartilage and calcareous granules, was also noticed, in order to shew the essential difference between them and the truly osseous portion of the vertebræ.

From these peculiarities in the spinal column of the Plagiostomi (Rays and Sharks), taken in connection with the higher degree of development of their nervous, generative, and digestive systems, the author concluded, that these fishes ought to form a new subclass, and, in the descending scale of organization, be placed at the head of the fishes, as they manifestly form the connecting link between the osseous fishes and the reptiles. He also concluded, that the Sturiones and Cyclostomi ought to be arranged together as a distinct subclass, to which the term of *cartilaginous* might still be retained, and be placed after the osseous fishes, in the descending scale of natural classification; as the lower grade of development of their whole systems, taken along with their essentially cartilaginous skeletons, constituted them the connecting link between the higher mollusca and the more imperfectly organized osseous fishes.

The paper was concluded by pointing out the probable importance

to the geologist of the discovery of an osseous structure in the vertebral columns of the Plagiostomi, and one or two instances were referred to in illustration of this part of the subject.

2. Farther Observations on Glaciers, by Professor Forbes.

Previous to the reading of the papers, the President announced that the Keith Prize had been awarded by the Council to Professor Forbes for his Papers on Glaciers.

The following Gentlemen were duly elected Ordinary Fellows of the Society :—

Nicholas Grut, Esq.
Rev. Archibald Bennie, one of the Ministers of the City.
David Stevenson, Esq., Civil Engineer.
Dr J. Y. Simpson, Professor of Midwifery, Edin. Univ.

The following Donations of Books to the Society's Library were announced :—

Journal of the Royal Geographical Society of London. Vol. xiii. Part 1.—*By the Society.*

The American Journal of Science and Arts, conducted by Professor Silliman and Benjamin Silliman, Jun. January 1844.—*By the Editors.*

Scheikundige Onderzoekingen, Gedaan in het Laboratorium der Utrechtsche Hoogeschool. 2d Deel. 2d Stuk.—*By the Editors.*

Flora Batava. No. 131.—*By the King of Holland.*

Maps of the Ordnance Survey of England and Wales. Sheets Nos. 88 and 89. *By the Master-General of the Ordnance.*

Kongl. Vetenskaps—Academiens Handlingar för Ar 1841.

Arsberättelse om Framstegen i Kemi och Mineralogi, af Jac. Berzelius, för 1841, 1842, och 1843.

Arsberättelse om Technologiens Framsteg Ar 1841, af G. E. Patsch.

Arsberättelse om Zoologiens Framsteg under Aren 1840, 1842, af C. H. Boheman.

Berättelse om Astronomiens Framsteg för Aren 1837, 1841, af N. H. Selander.—*By the Royal Academy of Sweden.*

Monday, 1*st April* 1844.

Sir T. M. BRISBANE, President, Bart., in the Chair.

The following communications were read :—

1. On the Development, Structure, and Economy of the Acephalocysts of Authors ; with an Account of the Natural Analogies of the Entozoa in general. By Harry D. S. Goodsir, Conservator of the Museum of the Royal Coll. Surg. Edin. Communicated by John Goodsir, Esq.

The Acephalocyst or Hydatid is composed of a vesicle containing fluid. It propagates by means of internal gemmules, which are developed between the layers of the membrane composing the vesicle, and, after a certain time, are thrown off internally.

The author, after pointing out these distinguishing characters of the Hydatid, referred to the confusion which had arisen, from want of proper observations on this point, and which, with other causes, had been the reason why the animal nature of these creatures had been denied by some writers of great authority.

The author having procured a new form of Acephalocyst, was enabled, from his observations on its structure and economy, to determine several important points relative to the anatomy, physiology, and natural history of the other species of the class.

He characterised this new species of Acephalocyst as a compound animal, inasmuch as one continuous membrane covered a complete group or mass of the Hydatids. This membrane was described as onsisting almost entirely of tubuli, ramifying freely through it, and a number of ovoid disks scattered at short intervals over its surface, the edges of which were lined with minute open stomata, which opened into the tubuli. The author looked upon these tubuli and stomata as the organs of nutrition.

Another membrane lay immediately beneath that already described, and covered each Hydatid in particular. The body of the Hydatid itself consisted entirely of a homogeneous mass of gelatine, intersected by a number of very delicate septa.

The author now described the mode of propagation, which he stated was analogous to that of the polyps, in so far, that, 1*st*, there was a number of ova thrown off for the extension of the parent group ; and, 2*d*, another generation for the extension of the species generally. These ovules arose from the internal surface of the ex-

ternal tubular membrane, and consisted of a parent cell, containing young ones within it.

The author here directed attention particularly to the mode of growth in this and the simple Acephalocyst, as compared with that of the next known animal in the class, viz., the Cænurus. He stated, that, in the first (Hydatid), one cell was thrown off from the internal surface of the vesicle, which increased in size by simple dilatation, without any cellular development whatever. The growth of the new form of Acephalocyst was exactly similar,—with this difference, that originally there was a parent cell which formed a number of young cells within it, each of which afterwards became the separate individual, by simple dilatation also.

The author, after describing the adult Cænurus, then proceeded to state the observations he had made on its development from the ovule upwards. He stated, that the ovule, when observed within the body of the parent animal, was composed, first, of a germinal spot within a germinal vesicle, and which was enclosed in a yolk of very considerable size. The yolk, again, was surrounded by a very thin layer of albumen, defended by the shell or external covering.* After the ovum escaped from the parent, the germinal spot increased very much in size, and a small clear spot appeared in its centre.

During the third stage, the germinal spot had increased considerably in size, and had become nodulated; the central spot had also increased in size.

During the fourth stage, the nodules had become separate cells, surrounding a central cell, which had also a germinal spot within it. This again underwent similar changes, and was succeeded in turn by other crops of cells in like succession. This formation of cells, from a succession of centres, only extended the growth in a lateral direction, the author therefore named this the discoidal *period* of growth, which again he subdivided into minor *stages*.

After describing all the stages of discoidal development, he proceeded to point out a change that took place in the mode of development of the cells, and which, according to the direction of growth, he named the vertical *period* of growth.

During the discoidal *period* of development, all the cells were produced from one series or succession of centres; but during the vertical *period*, instead of one, there were several, each of which form

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* The author looks upon these parts of the ovule as merely analogous to those of the higher animals.

young cells. The excentric cells of this *period* were all productive, and so, able to form new centres. The number of centres, however, were always limited, owing to the liquefaction and absorption of numerous peripheral cells.

The author, in the concluding part of his paper, stated, that during his observations, he was led to perceive the existence of many beautiful analogies between the Entozoa and the species belonging to other classes of the animal kingdom.

The volvox among the infusoria, he considered as the analogue of the Hydatid, and illustrated this by examining their economy comparatively.

The Alcyonidium among the Polyps, is the analogue of the new form of Acephalocyst. Ova in both cases being developed, 1*st*, for the purpose of increasing the bulk of the parent group; and, 2*d*, for the purpose of being distributed generally, to form separate and independent groups. In the function of nutrition the analogy also held true, inasmuch as each of the stomata or disks, it may be, supplied nourishment to the whole group, as well as to its own particular part; in the Alcyonidium, each polype acts as a mouth for the group.

Proceeding upwards in the scale, the author looks upon Diplozoon as the analogue of the Asterias, Tristoma, as that of Scutella and Distoma, that of Echinus; and brought forward an interesting observation, which he thought decisive as to the propriety of the analogies drawn between these Entozoa and Echinodermata, namely, that as the Echinus is merely an Asterias, with the rays folded back, so as to meet at the tips and form a globe, so is the Distoma merely a Diplozoon, with the two bodies folded together.

The Acanthocephala, of which the Echinorynchi are the types, are analogues of the Crustacea, through the Lerneæ. The Cœlelmintha, of which the Lumbricoides are the types, are analogous to the Annelida through the Lumbrici.

2. Account of a Repetition of Dr Samuel Brown's Processes for the Conversion of Carbon into Silicon. By George Wilson, M.D., Lecturer on Chemistry; and John Crombie Brown, Esq. Communicated by the Secretary.

The authors commenced with an account of the trials they made with the Cyanide of lead; which, according to Dr Brown's most recent announcement, is resolved by his process into gaseous nitrogen

and silicon. In the first place, however, they could not succeed in obtaining a pure cyanide of that metal. For whether they decomposed the cyanide of potassium, or the hydrocyanate of ammonia containing an excess of hydrocyanic acid, by neutral acetate of lead, by this salt acidulated with acetic acid, or by tribasic acetate, they constantly obtained a compound containing a large quantity of a hydrated basic acetate of lead; and they were not more successful when they substituted other salts of lead for the acetate as a precipitant, such as the nitrate, basic nitrate, nitrite, chloride, or iodide. It was impossible, therefore, to obtain atomic results with the cyanide of lead. But several of the precipitates, obtained in the ways now mentioned, were subjected nevertheless to Dr Brown's process, and there was obtained a brown substance, which they expected to prove to be silicon. When fused, however, with carbonate of potash, instead of yielding more than twice its weight of silica, it gave only a tenth of its weight of a yellowish-white substance, which was not examined with any particular care, but which seemed to correspond with silica in its leading properties.

The Cyanides of copper and zinc were also rejected after adequate trials; and recourse was then had to the Cyanide of silver, which, it is well known, may be readily obtained pure and definite in composition. When similarly treated as in the process with cyanide of lead, it was converted by heat into a brown powder, with the loss of only a 400th of its weight; and when this was fused with carbonate of potash, there was obtained from the product a notable quantity of a substance corresponding in properties with silica, but still much inferior in quantity to what ought to have been obtained, had the whole carbon of the cyanide become silicon.

The authors next mentioned the results they obtained with the Ferrocyanides. The Ferrocyanide of potassium, when heated with carbonate of potash at a white heat, according to Dr Brown's earlier process, yielded them a saline mass, in which, in many trials, they could obtain only traces of a substance corresponding with silica in properties. Ferrocyanide of lead also yielded traces; Prussian blue none; Ferrocyanide of copper rather more than the similar salt of lead.

They then turned to Paracyanogen, which they treated repeatedly by Dr Brown's method of fusion with carbonate of potash. They were foiled, however, in obtaining his results. Paracyanogen obtained from cyanide of mercury, and purified by boiling it first with water, and then with solution of carbonate of potash, gave off, not

nitrogen only, as Dr Brown has stated, but also carbonic acid and carbonic oxide; and the residue contained carbon. The authors, however, obtained some silica in the greater number of cases; occasionally none, even from paracyanogen prepared by Dr Brown himself; frequently very little; and never nearly the quantity which ought to have been obtained had the whole carbon become silicon, but fifteen per cent. at the utmost.

They also varied the process with Paracyanogen, by heating it alone for three days over an argand gas-flame in a malleable-iron crucible, luted and coated with stucco. A nut-brown powder, weighing 4.2 grains, was thus obtained from 18.5 grains of Paracyanogen. When 3.9 grains of this were fused with carbonate of potash, and the product treated as if it contained silicate of potash, the authors obtained 8.4 grains of a substance undistinguishable by any characters from silica. Had the brown powder been silicon, the product in this form should have been 8.11 grains. This experiment was twice repeated unsuccessfully.

The authors believe the substance obtained on this and other occasions to have been silica on the following grounds. It was a white, gritty powder, unalterable by ebullition in aqua regia for hours, or by exposure to a white heat, or to the full blow-pipe blast; fusible into a glass bead with carbonate of soda before the blow-pipe; soluble with effervescence in fused alkaline carbonates, and recoverable from the product without any change of property; convertible, when heated with potassium, into a substance undistinguishable from silicon; and yielding fluo-silicic acid when heated with fluor-spar and sulphuric acid.

In conclusion, they deny that it is possible to ascribe the appearance of the silicon and silica in these experiments either to impurity of the re-agents employed, or to action upon the vessels constituting the apparatus. They consider, therefore, that silicon was produced in an anomalous manner; but they do not admit that it is proved to have come from the carbon; for it might have been derived as well from the nitrogen, or from both elements together. And they state, that they abandoned the farther trial of Dr Brown's processes, because they became satisfied, that his experiments cannot be repeated at will; and that the conditions essential to success have not been ascertained, nor the details of the processes sufficiently worked out, to afford the means of establishing the transmutability of carbon into silicon on quantitative grounds.

3. On Dr Mathew Stewart's General Theorems. By T. S. Davies, Esq, F.R.S.E.

The following Donations were presented to the Society since the last Meeting:—

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. i., Nos. 30, 31, 32, and 33.—*By the Academy.*

Proceedings of the Royal Irish Academy for the years 1841-42, and 1842-43.—*By the Academy.*

Sketch of the Civil Engineering of North America. By David Stevenson, Civil Engineer.—*By the Author.*

A Treatise on the Application of Marine Surveying and Hydrometry to the Practice of Civil Engineering. By David Stevenson, Civil Engineer.—*By the Author.*

Monday, 15th April 1844.

Very Rev. Principal LEE, V.P., in the Chair.

The following communication was read:—

1. Inquiry into the Aborigines of the British Islands. Part 2. On the claims of the Cymric and Gaelic races to be thus considered. By Dr S. Hibbert Ware.

In the first part of the present memoir, it was shewn that Cæsar divided Gaul into three parts, of which one was inhabited by the Belgæ, another by those who, in their own language, were called Celtæ, but who, by the Romans, were named Gauls, and a third by the Aquitani. These three nations, according to the Roman historian, differed from each other in language, custom, and laws; but it was remarked by the author, that they also differed from each other in physical characters,—the Belgæ possessing what is named a Cymric type, the Gauls proper a Gaulish type, and the Aquitani an Iberian type. All these three races were to be distinguished from the zanthous, light-haired, Germanic tribes of the West of Europe, not only by the dark colour of the hair and eyes, but by other particulars, as the form of the head, &c.

The present memoir was confined to (1*st*), the Cymric race, and (2*dly*), the Gaelic race.

(1*st*), *The Cymric race.*—The physiological distinction of Cymri and Gaelic races was first established by the late Dr W. F. Edwards,

in his memoir "Des Caractères Physiologiques des Races d'Humain." The Cymric head is long, and often failing in width. The forehead is large and high; the nose curved, with the extremity depressed, and the nasal ailes raised or turned up; the chin strongly marked and prominent, and the stature tall. It was also explained by the author that these physical characters were associated with a distinct moral type.

It was argued, in the present memoir, that the Cymri had no real pretensions whatever to consider themselves (as in the ancient British triads) a primitive race in Britain. In tracing their progress from their oriental sojourning place to the remote west, they appear to have taken possession of no ground in any part of Europe which had not been preoccupied by other races. The author, in the course of arriving at this conclusion, gave the following historical account of the Cymri.

Sogdiana and Bactriana appear to have been the cradle of this race. At the present day, the Cymric type may be identified among the wandering tribes of Beloochistan, of which the author had evidence in some very accurate drawings, executed for him by his late son, during the expedition of Lord Kean.

The course of Cymric migration from east to west, was inferred by the occasional light which history affords of the physical characters of this early race, aided also by philological tests. The Cymric type is to be detected among some of the tribes anciently dwelling between the Caspian and Euxine seas, and in certain Egyptian sculptures, as figured by Rosallini, of the *Feccaro* (named by Wilkinson, *Tokkari*) dwelling, in the time of Rameses the Third, not far from the eastern shores of the Mediterranean. Various kinds of evidence also demonstrate, that the Cymri are to be traced, during their westerly migration, in Persia, along the shores of the Black Sea, in Greece, in Italy, and in the tracts watered by the Danube and the Rhine. They again appear as confederated tribes, known by the appellation of Boii, and Belgæ. Under the name of Firbolgs (Viri Bolgæ), they peopled Ireland, and, in occupying England and Scotland, they were lastly driven, by Saxon inroads, to the mountainous recesses of Wales. Various details of the greater or less prevalence of the Cymric type, as it is to be traced in these different countries, were supplied by the author.

(*2dly*), *The Gaulish, or Gaelic race.*—According to Dr Edwards, the head is round, so as to approach in a manner to a spherical form; the forehead is moderate, a little swelled out, and retreating

towards the temples; the eyes are large and open; the nose, in tracing it from the depression at its origin, is nearly straight, or without any marked curvature, and rounded at the extremity; the chin is also rounded. Lastly, the height is moderate; which, as Thierry, in his Histoire des Gaulois, first shewed, is an important historical distinction: for whenever the Romans spoke of the gigantic height of the Gauls, they meant their Cymric, and not their Gaelic foes. It was also explained that the moral type of the Gauls differed much from that of the Cymric race.

In considering the claims of the Gaelic race to be ranked as aboriginal in Britain, the author entered upon two questions, (*a*) their original sojourning place, and (*b*) their course of migration.

(*a*) The *Asiatic* cradle of the Gaelic race.—The author, after noticing the suspicion of Baron Larrey, that Arabia was to be thus considered, as well as the various opinions on this subject, advanced by Vallancey, Dr O'Conor, Sir William Betham, and others, was inclined to believe that the primitive Gauls were a polished and civilized people, originally dwelling on the eastern coast of the Mediterranean, who, as maritime adventurers, visited the west of Europe on objects of traffic, particularly for the sake of the precious metals. He did not consider it as necessary to this opinion, that they should be identified with the Phœnicians, or any other nation equally maritime; but left this question to be determined by more satisfactory evidence than has hitherto been adduced, resulting from a comparison of physical characters. It was also observed, that the leading physical characters of the Gael, namely, the form of the head and features, appear in the figures of certain sculptured monuments of the very early period of Rameses the Third, which, from a discordancy in other respects, have greatly puzzled both Champollion, and Rosallini. These figures of a civilized people, richly attired, are referred to inhabitants of Canaan or its confines.

(*b*) The course of Gaelic migration to the West.—The author was disposed to consider, that evidence of the westerly course of Gaelic migration might probably be found in the commercial settlements which early maritime tribes may have formed on the Mediterranean coasts and islands. He, accordingly, adverted to the remark of Baron Larrey, relative to the identity of the western Arabs with Gaulish races,—to the assertion of Gesenius, that the Numidian language was a pure, or very nearly pure, Hebrew, such as was spoken by the ancient Canaanites or Phœnicians,—and to various Cyclopean structures in Malta, on the African coast, and elsewhere,

similar to those which characterise the westerly countries of the Gael. But the author dwelt most upon the account of the Turditani of Spain, as given by Pliny, to whom an early introduction of letters was ascribed, together with the use of valuable works of art wrought in the precious metals, resembling such as are constantly discovered in Ireland, which indicate the very early state of civilization in this country. The author then entered into a detailed description, from personal observation, of the greater or less frequency of the Gaelic type in France, Ireland, Scotland, and Wales; and of the causes to which its disappearance in many extensive districts might have been attributable.

After these explanations, the general question was considered,—What race ought to be regarded as aboriginal in the British islands? Llwyd had long since shewn, from the language of topography, that the Gauls had preceded the Cymri in the occupation of Britain. But it was asked,—if there might not have been a still earlier race existing in this country than the maritime and commercial Gauls?

To this question an answer was given in the affirmative. Tacitus, in his enumeration of British races, has suggested, that an ancient Iberian stock, remarkable for a swarthy complexion and curled hair, might have passed over and occupied the seat of the Silures (in South Wales);—a British tribe, with whom he was disposed to identify this primitive race of Spain.

It was then stated, that the author had collected abundant evidence which leads to the conclusion, that an Iberian, or Aquitanian race, was an older one in Britain than either of the two whose pretensions he had discussed; but that it would be in vain to establish their aboriginal claims, unless the history of the Cymri and the Gael, in reference not only to their Asiatic sojourning place, but also to their westerly course of migration, was well understood. He, lastly, expressed his hope, that, if the aboriginal claims of the Iberian race meet with confirmation, some light would be thrown upon the fossil bones of the human species which are found in caves, or buried deep in strata of peat, occasionally associated with the remains of animals now extinct, which have had an existence prior even to the records of history.

2. On the Knowledge of Distance given by Binocular Visions. By Sir David Brewster, K.H.

The following Gentleman was duly elected an Ordinary Fellow of the Society :—

Dr Thomas R. Colledge, Fel. Roy. Coll. Phys. Edin.

The following Donations of Books to the Society's Library were announced,

The Electrical Magazine. Conducted by Mr Charles V. Walker. Vol I., No. 2.—*By the Editor.*

Literarische Sympathien oder industrielle Buchmacherei: Ein Beitrag zur Geschichte der neueren Englischen Lexicographie, von Dr J. G. Flugel.—*By the Author.*

Fifty-Fifth Annual Report of the Regents of the University of the State of New York.—*By Dr Christison.*

Journal of the Asiatic Society of Bengal. Nos. 136, 137, 138, and 139.—*By the Society.*

Travels through the Alps of Savoy, and the other parts of the Parisime Chain, with observations on the phenomena of Glaciers. By James D. Forbes, F.R.S.S.L. and E., &c. &c.—*By the Author.*

Monday 6th May 1844.

Dr ABERCROMBY, V.P., in the Chair,

The following communications were read :—

1. On the Conversion of Relief by Inverted Vision. By Sir David Brewster, K.H.

2. On the Geology of Cockburn-Law and its Neighbourhood, By William Stevenson, Dunse. Communicated by David Milne, Esq.

The author, in the first part of his paper, described the nature of the formations, and in the last part offered his views in explanation of the appearances.

In describing the formations, he enumerated, first, those of *aqueous*, and last those of *ligneous* origin.

I. The former consist of the greywacke, the old red sandstone, and the coal-measure formations.

(1.) The *greywacke* strata form the summit of Cockburn-Law, having a strike about NE. and SW. nearly vertical. There appears to be no decided evidence of any organic remains in these strata;—there are curious markings which are most probably only concretionary. At Hoardwheel, situated to the eastward of Cockburn-Law, two varieties of copper ore are found in the greywacke, the green and the grey, the former of which is the most plentiful, and imparts a beautiful hue to the rocks. The oxide of manganese is also widely diffused.

(2.) The *old red sandstone* strata lie over the upturned edges of the greywacke, and have therefore been deposited at a more recent epoch. At a distance from the hills they are generally horizontal, or dip away at a gentle angle;—but at the sides of the hills they are highly inclined,—a circumstance probably caused by an upheaval of the hills, which took place after the date of this formation. These old red sandstones are extensively developed in Preston Haugh. The lowest bed consists of pebbles or fragments of rocks, both angular and rounded, derived from the wearing down of the greywacke and porphyritic rocks. The colour of this formation is, especially towards its base, of a red colour.

It is in this formation, that the bones, teeth, scales, and spines of the *Holoptichius nobilissimus*, a large ganoid fish, described by Agassiz, were found by the author in 1840. These are remains of the same kind of fish which have been found in Perthshire, England, Russia, and in other parts of the globe, and which abounded at the epoch of the old red sandstone formation; for wherever it is found, these particular rocks prevail. The nature of the strata in which it is found—a coarse, gritty sandstone—seems to indicate that the *Holoptichius* swam about in waters near the shore; another proof of which is afforded by the ripple marks on the sandstone slabs near their place of sepulture. These interesting relics are very abundant in the strata opposite to Cockburn Mill, and also about half a mile below it, on the right bank of the Whitadder.

(3.) The *coal-measure* strata lie above the old red sandstone rocks, but are not disconformable to them in dip. They are to be seen in the Whitadder, below Preston Bridge, and consist of the ordinary sandstones, shales, and strata of ironstone. The only fossils prevailing in them are those of terrestrial vegetables, which probably had been drifted by rivers.

II. The *Igneous* rocks were divided by the author into two classes—one of which he described as the Felspathic, the other as the Augitic.

(1.) The *Felspathic* rocks comprehend all those igneous rocks associated with the greywacke strata, consisting of the granites, and syenites, and old porphyries of Cockburn-Law, the Staneshiel, the Knock Hill, Blackerstone Hill, &c. The central parts of these igneous masses present the most crystalline appearance, consisting there of pyramidal and wedge-shaped blocks. In those parts approaching to and in contact with the greywacke strata, a rhomboidal parallelopiped structure prevails,—which also characterises the aqueous rocks when in contact with the igneous. It is interesting to notice the effect produced on the greywacke strata, by the outburst through and among them of these igneous rocks. Where the two kinds of rocks are immediately in contact, all signs of stratification in the greywacke have been obliterated; and, indeed, these strata appear to have been metamorphosed into syenite.

(2.) The *Augitic* trap-rocks exist almost entirely among the more recent aqueous rocks, viz. the old red sandstones and coal-measures. They are seldom or never seen within the range of the greywacke formation, at least in this neighbourhood.

These augitic traps exist both in the form of narrow dykes, and in that of great masses constituting hills. Of the former, the Cumledge trap-dyke is a good example. It is seen in the bed of Oxendean Burn at Cumledge House, and there forms in amygdaloidal greenstone, abounding in veins of zeolite, steatite, and other minerals. The width of the dyke at this place is about ten yards. The average direction of the dyke is NN.W. and SS.E. It has had the effect, as usual, of hardening the strata on each side of it. This dyke has been traced by the author for a considerable distance, running through both the old red sandstone and coal-measure formations. It appears also to reach into the granite of the Staneshiel and Cockburn-Law.

An overflow of amygdaloidal trap is to be seen on the left bank of the Whitadder, below Cockburn Mill, forming a bed of about four feet thick, and lying above the old red sandstone strata. There are large accumulations of greenstone at Borthwick and Castle Mains. Dunse-Law is also composed of basalt.

In the *second* part of his paper, the author shewed that the outburst of the granite and other felspathic rocks had taken place simultaneously with the upsetting of the greywacke formation, and before the deposition of the old red sandstones. He also stated, that when, after the deposition of the coal-measures, a new outburst of igneous rocks took place, the Lammermuir chain probably received an ad-

ditional upheave,—as the considerable dip of the old red sandstone from that chain could not otherwise be very well accounted for. The colour of the old red sandstones he attributed to the wearing down of the greywacke and porphyritic rocks of a red colour. The reason why the outburst of the porphyritic rocks took place before the augitic traps, he supposed might be the smaller specific gravity of the former.

Mr Stevenson's paper was illustrated by a geological map, as well as by numerous sections.

3. Notice regarding The Indian Grass Oil, or Oil of Andropogon Calamus-aromaticus. By Thomas G. Tilley, Phil. D. Communicated by Dr Christison.

The oil known as Indian Grass Oil, has been referred by Dr Royle to the Andropogon Calamus-aromaticus, a plant which he conceives to be identical with the Καλαμος αρωματικος of the Greeks. It has been used in medicine as a stimulant embrocation in rheumatism, &c.

The oil, which was green, became yellow when heated. It acquired a steady boiling point at 440°, between which temperature and 442°, a transparent colourless oil distil over. This, after rectification by chloride of calcium, was analysed, and found to have the following composition.

	Found.	Atoms.	Calculated.
Carbon	88.10	10	88.46.
Hydrogen	11.29	16	11.54.

from which data, it appears that the oil of grass contains, and chiefly consists of a carbo-hydrogen, in which the proportion of the carbon is to the hydrogen, as 10 to 16, as in the case of oil of turpentine, and other volatile oils of the same class.

The following Donations of Books to the Society's Library were announced:—

Mémoires présentés par divers Savants à l'Académie Royale des Sciences de l'Institut de France. Tome viii.—*By the Royal Academy.*

Mémoires de la Société de Physique et d'Histoire Naturelle de Genève. Tome x., Part 1.—*By the Society.*

Annales des Sciences Physiques et Naturelles d'Agriculture et

d'Industrie de Lyon. Tome v.—*By the Royal Society of Agriculture at Lyons.*

Bulletin de la Société Géologique de France. (Deuxieme Serie.) Tome i. Feuilles 8-10.—*By the Society.*

Memoirs of the Literary and Philosophical Society of Manchester. Vol. vii., Part. 1.—*By the Society.*

Journal of the Statistical Society of London. Vol. vii., Part 1.—*By the Society.*

Scheikundige Onderzoekingen, gedaan in het Laboratorium der Utretchtsche Hoogeschool. Deel ii. Stuk 4.—*By the Editors.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Tome xvii., Nos. 25 and 26; and Tom. xviii., Nos. 1-14.—*By the Academy.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. II. 1847–8. No. 31.

Monday, May 3, 1847.

The following Donations of Books to the Library were announced:—

Memoirs and Proceedings of the Chemical Society. Part 20. 8vo. —*By the Society.*

The American Journal of Science and Arts. Conducted by Professors Silliman and J. D. Dana. For March 1847. 8vo.—*By the Editors.*

On three several Hurricanes of the Atlantic, and their relations to the Northers of Mexico and Central America, with notices of other storms. By W. C. Redfield. 8vo.—*By the Author.*

Proceedings of the American Academy of Arts and Sciences, May 26, 1846. 8vo.—*By the Academy.*

The Fourteenth Annual Report of the Royal Cornwall Polytechnic Society, 1846. 8vo.—*By the Society.*

Magnetical and Meteorological Observations made at the Royal Observatory, Greenwich, in the year 1844. Under the direction of George Biddell Airy, Esq., M.A., Astronomer-Royal. 4to. —*By the Royal Society.*

Sixty-Fifth Session.

First Ordinary Meeting, 6th December 1847.

Sir THOMAS MAKDOUGAL BRISBANE, Bart., President, in the Chair.

The following Communications were read:—

1. Biographical Memoir of the late Dr Hope. By Dr Traill.

2. Note on the Constitution of the Phosphates of the Organic Alkalies. By Dr Thomas Anderson.

The author had been led to investigate the phosphates of the organic alkalies, with the view of determining the accuracy of an analysis of the phosphate of strychnia by Regnault, which gave results incompatible with the known constitution of the inorganic phosphates. He alluded to the investigation of the phosphates of aniline by Nicholson, and proceeded to the statement of his own observations.

Phosphate of Strychnia, with one equivalent of Strychnia, was obtained in long truncated needles, by digesting strychnia in tribasic phosphoric acid. It dissolved readily in water, and was acid to test-paper. By analysis it gave results corresponding to the formula

$$(C_{44} H_{23} N_2 O_4 HO) 2 HO PO_5$$

The crystallized salt was found to contain 4 equivalents of water of crystalization.

Phosphate of Strychnia, with two equivalents of Strychnia. By long-continued digestion of strychnia with the foregoing water in solution, an additional atom of the alkaloid is dissolved, and the solution on cooling deposits rectangular tables of a salt which is neutral to test-paper. It is less soluble in water than the acid phosphate, and its constitution was found to be represented by the formula

$$2 (C_{44} H_{23} N_2 O_4 HO) HO PO_5$$

Phosphate of Brucia, with two equivalents of Brucia, is obtained by the solution of Brucia in phosphoric acid, and crystallizes from the concentrated solution in short prisms. The crystals are neutral to test-paper, and contain a large quantity of water of crystallization, which they lose by efflorescence. The formula of the salt is

$$2 (C_{44} H_{23} N_2 O_7 HO) HO PO_5$$

A double phosphate of Brucia and soda was also formed, but could not be obtained perfectly pure.

Phosphate of Quinine, with three equivalents of Quinine. By digesting quinine with phosphoric acid, a solution of this salt is obtained, which becomes a solid mass of silky needles on cooling. They are extremely soluble in hot water, and are quite neutral to test-paper. They gave, by analysis, a result corresponding with

$$3\,(C_{20}\,H_{12}\,NO_2\,HO)\,PO_5$$

These results the author considered sufficient to establish the fact, that the phosphate of the organic alkalies agree in their constitution with the inorganic salts of that acid ; and he concluded his paper by observing, that the relations of these bases to phosphoric acid might be made use of as a means of classifying them. Thus quinine, which replaces three equivalents of water in phosphoric acid, might be compared to oxide of lead and the oxides of the heavy metals. Brucia might represent the inorganic alkalies. While strychnia, which, under ordinary circumstances, replaces only one equivalent of water, belongs to a class which has no analogue among the series of inorganic bases.

The following Donations to the Library were announced:

Annals of the Lyceum of Natural History of New York. Vol. IV., No. 67. 8vo.—*By the Society.*

Address delivered at the Anniversary Meeting of the Geological Society of London, on the 19th February 1847. By Leonard Horner, V.P.R.S., President of the Society. 8vo.—*By the Author.*

Proceedings of the American Philosophical Society. Vol. IV., No. 34. 8vo.

Transactions of the American Philosophical Society, held at Philadelphia, for Promoting Useful Knowledge. Vol. IX., Part 3. —*By the Society.*

A Treatise on Atmospheric Phenomena. By Edward Joseph Lowe, Esq., 8vo.—*By the Author.*

Annales de l'Observatoire Royal de Bruxelles. Tom. V.—*By M. A. Quetelet.*

Mémoires Couronnés et Mémoires des Savants Etrangers, par l'Académie Royale de Bruxelles. Tom. IX., 1845 et 1846 ; Tom. XX., 1846, 2 Parties ; Tom. XXI., 1846. 4to.—*By the Academy.*

Nouveaux Mémoires de l'Académie Royale des Sciences et Belles Lettres de Bruxelles. Tom. XIX. 4to.—*By the Academy.*

Mémoires de l'Académie Royale des Sciences, des Lettres, et des Beaux Arts de Belgique. Tom. XX. 8vo.—*By the Academy.*

Bulletin de l'Académie Royale des Sciences, des Lettres, et des Beaux Arts de Belgique. Tom. XIII. (complète) et Tom. XIV., Nos. 1, 2, 3, 4, 5, 6. 8vo.—*By the Academy.*

Bulletin de la Commission Centrale de Satistique de Belgique. Ext. de Tom. III., sur les Anciens Recensements de la Population Belge, par M. Quetelet; et la même livraison, De l'Influence du Libre Arbitre de l'Homme sur les Faits Sociaux. Par M. A. Quetelet. 8vo.—*By the Author.*

Bulletin de la Société Impériale des Naturalistes de Moscou. Nos. 3, 4 (1846); No. 1 (1847). 8vo.

Séance Extraordinaire de la même Société, du 22 Février 1847. 8vo. —*By the Society.*

Berichte Über die Mittheilungen von Freunden der Naturwissenschaften in Wien. Von W. Haidinger. Band I., Nos. 1—6, und Subscriptions Liste. 8vo.—*By the Author.*

Bulletin der Königl. Akademie der Wissenschaften zu Berlin. Nos. 1–77. 8vo.—*By the Academy.*

Gelehrte Anzeigen, von der Akademie der Wissenschaften zu Berlin. Bde. 16–23. 8vo.—*By the Academy.*

Abhandlungen der Mathematisch-Physikalischen Classe der Königl. Bayerischen Akademie der Wissenschaften. 4 Band. 3 Abtheilung. 4to.—*By the Academy.*

Über das Studium der Griechischen und Römischen Alterthümer. Von Ernest von Lasaulx.—*By the Author.*

Über die Ordealien bei den Germanen in ihrem Zusammenhange mit der Religion. Von Georg Phillips. 8vo.—*By the Author.*

Die Überbleibsel der Altægyptischen Menschenrace. Von Dr Franz Pruner. 8vo.—*By the Author.*

Almanach der Akademie der Wissenschaften zu Göttingen, für 1847. 8vo.—*By the Academy.*

Annuaire de l'Académie Royale de Belgique, 1846 & 1847. 8vo.—*By the Academy.*

Annuaire de l'Observatoire Royale de Bruxelles. Par M. Quetelet. 1847.—*By the Author.*

Journal of Agriculture, and Transactions of the Highland and Agricultural Society of Scotland. No. 17 (July) and No. 18 (October) 1847. 8vo.—*By the Society.*

Journal of the Statistical Society of London. Vol. X., Part 3. 8vo. —*By the Society.*

Quarterly Journal of the Geological Society. No. 2 (August). 8vo. —*By the Society.*

Monthly Journal of Medical Science. No. 81 (September). 8vo. —*By the Editor.*

Thirteenth Annual Report of the Royal Cornwall Polytechnic Society. 8vo.—*By the Society.*

Journal of the Royal Asiatic Society. Vol. X., Parts 2 and 3. 8vo. —*By the Society.*

Journal of the Asiatic Society of Bengal. Edited by the Secretary. Nos. 171, 172, 173. 1846. 8vo.—*By the Editor.*

Do. do. Edited by the Secretaries. New Series. Nos. 174, 175, 176, and 181; with Supplementary Number published January 1847. 8vo.—*By the Editors.*

American Journal of Science and Arts. Conducted by Professors Silliman and Dana. Second Series. Nos. 5, 8, 9, 10, 11. 8vo.—*By the Editors.*

Philosophical Transactions of the Royal Society of London. Part 1, 1847. 4to.—*By the Society.*

Kongelike Dánske Videnskabernes Selskabs Naturvidenskabelige og Mathematiske Afhandlinger. Tolvte Deel. 4to.—*By the Royal Society of Sciences of Copenhagen.*

Flora Batava. No. 147. 4to.—*By the King of the Netherlands.*

Handbuch der Mineralogie. Von J. F. L. Hausmann. 2 Theil. 8vo.—*By the Author.*

Astronomische Beobachtungen der Königl. Universitäts-Sternwarte in Königsberg. Von F. W. Bessel. 19 and 21 Abtheilung. Fol.—*By the Author.*

Annales de la Société Royale d'Agriculture de Lyon. Tom. VIII. 1845.—*By the Society.*

Recherches sur les Mouvements de la Planête Herschel. Par M. Le Verrier. 1846.—*By the Author.*

Ankuendigung und Probe einer Neuen Kritischen Ausgabe, und Neuen Uebersetzung der Syrischen Chronik, des Gregor Bar-Hebraeus. Von G. H. Bernstein. 1847. 8vo.—*By the Author.*

Sur la Publication des Monuments de la Géographie. 8vo.—*By the Author.*

Satistique Générale. Rapport au Ministre de l'Intérieur sur les Travaux de la Commission Centrale, et des Commissions Provinciales de Satistique.—*By M. A. Quetelet.*

Rapport sur les Travaux de l'Académie Royale des Sciences et Belles Lettres de Bruxelles, pendant l'année 1842–43. Par A. Quetelet. 8vo.—*By the Author.*

Rapport sur les Travaux et les Titres Scientifiques de M. Duponchel, lu à la Société des Enfants du Nord. 2 copies. 8vo.—*By the Society.*

Bulletin des Séances de la Société Vaudoise des Sciences Naturelles. Nos. 14 & 15. 8vo.—*By the Society.*

Censura Commentationum Soc. Reg. Danicæ Scientiarum, anno 1846, ad præmium reportandum oblatarum.—*By the Society.*

Öfversigt över det Kongelike Dânske Videnskabernes Selskabs Forhandlinger, og dets Medlemmers Arbeider i Aaret, 1846, af H. C. Örsted. 8vo.—*By the Author.*

On the Nucleus of the Animal and Vegetable "Cell." By Martin Barry, M.D. 8vo.—*By the Author.*

Memoirs and Proceedings of the Chemical Society. Part 21. 8vo. —*By the Society.*

On the Origin of Continents. By James D. Dana. 8vo.

Origin of the Grand Outline Features of the Earth. By James D. Dana. 8vo.—*By the Author.*

Greenwich Astronomical Observations. 1845. 4to.—*By the Royal Society.*

Medico-Chirurgical Transactions. Vol. XIII. 8vo.—*By the Editor.*

Everest's Measurement of the Meridional Arc of India. With Plates. 4to.—*By the Directors of the East India Company.*

Results of Astronomical Observations at the Cape of Good Hope. By Sir J. F. W. Herschel, Baronet. 8vo.—*By the Duke of Northumberland.*

Researches for a Remedy against Communism. By Baron Dersenyis. 8vo.—*By the Author.*

Turner's Chemistry. 8th Edition. By Liebig and Gregory. 8vo. —*By the Editors.*

Description and Conquest of Ceylon. By Henry Marshall. 8vo. —*By the Author.*

Elements of General and Pathological Anatomy. Second Edition. By David Craigie, M.D. 8vo.—*By the Author.*

Observations on the Famine of 1846–7 in the Highlands of Scotland and in Ireland. By W. P. Alison, M.D. 8vo.—*By the Author.*

The Acts of the Parliaments of Scotland. Vol. I. (1124–1423.) Fol.

Acta Dominorum Concilii. Oct. 5, 1478 ad Nov. 15, 1495. Fol.

Acta Dominorum Auditorum. Oct. 9, 1466 ad Dec. 16, 1494. Fol.—*By the Lords Commissioners of the Treasury.*

Proceedings of the Royal Society. No. 67, 1846, and No. 68, 1847. 8vo.—*By the Society.*

Memorie della Reale Academia delle Scienze di Torino. Ser Seconda. Tom. III., IV., V., VI. 4to.—*By the Academy.*

Memoirs and Proceedings of the Chemical Society. Part 22. 4to. —*By the Society.*

Journal of the Statistical Society of London. Vol. X., Part 4. 8vo. —*By the Society.*

Observations on the Temple of Serapis. By Ch. Babbage. 8vo.—*By the Author.*

Bulletin de la Société de Géographie. 3ième Série, Tom. VII. 8vo. —*By the Society.*

Etudes d'Astronomie Stellaire. Par M. Struve. 1847. 8vo.—*By the Author.*

Die Cephalopoden des Salzkammergutes, aus der Sammlung Seiner Durchlaucht Fürsten Von Metternich. Von F. R. Von Hauer. 4to.—*By Prince Metternich.*

Journal of the Asiatic Society of Bèngal. Nos. 178 and 179, for May and June 1847; and Index to Vol. XV. 8vo.—*By the Society.*

Proceedings of the Zoological Society of London. Nos. 155, 177. 8vo.

Reports of Council and Auditors of the Zoological Society of London, for April 1847. 8vo.

A List of the Fellows, &c., of the Zoological Society of London, for April 1847.

Transactions of the Zoological Society of London. Vol. III., Part 4.—*By the Society.*

A large Collection of the Admiralty Charts of Great Britain.—*By the Lords Commissioners of the Admiralty.*

Monday, 20th December 1847.

Right Rev. BISHOP TERROT, V.P., in the Chair.

The following communication was read:

Examination of some Theories of German Writers, and of Mr Grote, on the Authorship of the Iliad and Odyssey. By Professor Dunbar.

In the first part of the paper the question was examined, whether the art of writing was known and practised at the time in which Homer is supposed to have lived? It was found that there was no evidence, either in the Iliad or Odyssey, that it was practised at that time; but that these poems must have been transmitted orally by the Bards for a period of nearly three centuries. It was then considered whether poems of such a length as the Iliad and Odyssey could have been composed and committed to memory by one man; and it was shewn, from several examples, that there was no impossibility in the matter. Mr Grote's theory, "that no such poet of the name of Homer ever existed," was then examined, and shewn, from the testimony of several of the most eminent Greek authors, to be fallacious. It was stated that lays, containing the history of the ancestors of powerful chiefs, were composed by the Bards attached to their families, and that Homer, in all probability, availed himself of them in working up the Iliad and Odyssey. The mode in which these poems were circulated through Greece by the Nomads, was next pointed out, by their reciting them on public occasions in every part of Greece. It was shewn that they were not committed to writing till a little before the age of Solon and Pisistratus. Wolfe and Lachmann's theories were then examined, and shewn to be altogether fallacious. The opinion of Mr Grote that the Iliad was first an Achilleis, and that the books, including the second and the subsequent ones to the eleventh, were the compositions of a later or later poets, was examined, and it was shewn, by a reference to several incidents in these books, that they must have been composed by the same author, and formed a necessary part of the story of the Iliad. It was stated, contrary to Mr Grote's opinion, that the Iliad possessed more unity than the Odyssey, and that internal evidence proved that it was in all probability composed by the author of the Iliad, and not by a piecing together of the lays of later poets. The opinions of some German critics, that the Odyssey was of a later date than the Iliad,

was then examined, and shewn to be well founded. It seemed likely to have been composed in Homer's old age, and bore the same resemblance to the Iliad in point of execution as the Paradise Regained of Milton to that of the Paradise Lost of the same poet. The paper concluded with a quotation from Mr Grote, in which he seemed to have departed from his original opinions.

The following Gentlemen were duly elected Ordinary Fellows:

John Wilson, Esq., F.G.S.
Moses Steven, Esq.

The following Donations to the Library were announced:—

Emploi de l'Airain à défaut du Fer chez la plupart des peuples des cinq parties du monde, &c. Notice intéressant les Peintres d'Histoire et les Archéologiques, Extraité du livre intitulé, Déconvertes dans la Troade. Par A. F. Mauduit. 3 copies. 8vo.—*By the Author.*

Défense de feu Le Chevalier, et du feu Comte de Choiseul Gouffier contre M. P. B. Webb. Par M. Mauduit. 4 copies.—*By the Author.*

Appendices du livre Découvertes dans la Troade, publié en 1840 par M. Mauduit; Défense de Le Chevalier et du Comte Choiseul Gouffier, &c. 4to.—*By the Author.*

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft bei ihrer Versammlung zu Chur. 1844. 4to.—*By the Society.*

Actes de la Société Helvétique des Sciences Naturelles. Trentième Session. 4to.—*By the Society.*

Journal of the Asiatic Society of Bengal; Edited by the Secretaries. September, No. 182. 8vo.—*By the Society.*

Scheikundige Onderzœckingen, gedaan in het Laboratorium der Utrechtsche Hooge-school. 4de Deel, 4de Stuk. 4to.—*By the University.*

Mittheilungen der Naturforschenden Gesellschaft in Bern, aus dem Jahre, 1844–46. Nos. 13–38, 57–86.—*By the Society.*

Bulletin de la Société des Sciences Naturelles de Neuchatel. 1844–45–46. Tom. 1. 8vo.—*By the Society.*

Mémoires de la Société des Sciences Naturelles de Neuchatel. Tom. I., II., III. 4to.—*By the Society.*

Abhandlungen der Königl. Akademie der Wissenschaften zu Berlin, aus dem Jahre 1845. 4to.—*By the Academy.*

Bericht über die zur Bekanntmachung geeigneten Verhandlungen der Königl., Preuss. Akademie der Wissenschaften zu Berlin. Juli—December 1846, und Januar—Juni 1847. 4to.—*By the Academy.*

Bemerkungen über Gyps und Karstenit, von J. F. L. Hausmann. 4to.—*By the Author.*

Nachrichten von der Georg-Augusts-Universität und der Königl. Gesellschaft der Wissenschaften zu Göttingen. 1846.—*By the Society.*

Tradescant der Aeltere 1618 in Russland. Von Dr J. Hamel. 4to.—*By the Author.*

Annuaire Magnétique et Météorologique du Corps des Ingénieurs des Mines de Russie, ou Recueil d'Observations Magnétiques et Météorologiques, par A. T. Kupffer. Année 1844. Nos. 1 & 2.—*By the Editor.*

An Engraving of the late Principal Robertson.—*By John Russell, Esq.*

Monday, 3d January 1848.

RIGHT REV. BISHOP TERROT, V.P., in the Chair.

The following communication was read:—

1. On Algebraical Symbolism. By Bishop Terrot.

The author commenced by proving the propriety of the adoption of the minus sign for quantities of an affection opposite to those affected by the plus sign, and detecting the limits within which this use of the absolute minus was reasonable and effective.

He observed that this was merely a particular case of the notation which symbolizes the inclination of lines by the factor $1^{\frac{\delta}{2\pi}}$, namely, the case where $\delta=180°$, and proceeded to shew within what limits the algebraical rules for the treatment of exponential quantities are applicable to the symbols of inclined lines.

After referring to the use of this notation in all the problems of plane Trigonometry, especially those which treat of the sines and cosines of multiple arcs, he gave some examples of its applicability

to some elementary propositions in the first and fourth books of Euclid.

The following Donations to the Library were announced:—

The American Journal of Science and Arts, conducted by Professors Silliman and Dana. Vol. IV., No. 12. November, 1847. 8vo.—*By the Editors.*

The Journal of Agriculture. N. S., No. 19. January, 1848. 8vo. —*By the Publishers.*

On certain Laws of Cohesive Attraction. By James D. Dana. 8vo.

A General Review of the Geological Effects of the Earth's Cooling from a State of Igneous Fusion. By James D. Dana. 8vo.

Conspectus Crustaceorum. Auctore Jacobo D. Dana. 8vo.—*By the Author.*

Leeds Philosophical and Literary Society. Annual Report. 1846-7. 8vo.—*By the Society.*

The Mathematical Analysis of Logic. By George Boole. 8vo.—*By the Author.*

Königl. Vetenskaps Handlingar, för Ar 1845. Hft. 1 & 2. Stockholm, 1847. 8vo.—*By the Academy.*

Öfversigt af Königl. Vetenskaps-Akademiens Förhandlingar. 1846. Nos. 7–10. 1847. Nos. 1-6. Stockholm. 8vo.—*By the Academy.*

Årsberättelse om Zoologiens Framsteg under Åren 1843–44. Af C. J. Sunderall. Stockholm, 1846. 8vo.—*By the Editor.*

Tal Hället vid Praes. Nedläggande uti Königl. Vetenskaps-Akademien, den 7 April 1841. Af N. G. Sefström. Stockholm, 1846. 8vo.—*By the Editor.*

Berättelse om Framstegen i Fysik, ären 1843 and 1844, afgiven till Königl. Vetenskaps-Akademien, af A. F. Svanbergoch, och P. A. Siljeström. Stockholm, 1847. 8vo.—*By the Editors.*

Memoirs of the Royal Astronomical Society. Vol. XVI. 4to.

Proceedings of the Royal Astronomical Society. Vol. VII., Nos. 1–17. 8vo.—*By the Society.*

Monthly Journal of Medical Science, No 85. January, 1848. 8vo. —*By the Editors.*

Monday, 17*th January* 1848.

Dr CHRISTISON, Vice-President, in the Chair.

The following Communications were read:—

1. Account of a Geological Examination of the Volcanoes of the Vivarais. By Professor Forbes.

The author having, on former occasions, stated some results of his travels in Auvergne and the Cantal, gives a more detailed description of the volcanoes of the Vivarais, which have been less frequently and less accurately described.

He first gives an account of the journey from Le Puy across the chain of the Cevennes which culminate at the volcanic summit of the Mezeuc, by the course of the Loire, to Montpezat in the department of the Ardêche.

The best descriptions of the Vivarais are those of Foujas de St Fond and Mr Scrope. The plates illustrating the work of the latter leave almost nothing to desire. These authors have described more or less fully the following volcanic orifices—Coupe de Jaujac, Souillolsor Neyvac, Mouleynes or Thuez; Montpezat and Aysac. Other writers have described the cone of Bauzou, and the (so-called) crater of Elevation of Pal, which are generally supposed not to have given birth to any lava stream. The present author has given a more minute and detailed account of each of these volcanoes, and of the great beds of basaltic lava to which they have respectively given birth. He discusses the relative age, the remarkably columnar structure, and the surprising erosion by water of these (comparatively modern) lava flows, which he illustrates by an exact map of the formations, based upon Cassini's, and by very numerous levels barometrically determined. He has also been able to add to the list of known volcanoes in this district, two craters which he believes never to have been described, occurring in remarkable positions, and giving rise to extensive lava streams, one in the valley of Budzet, the other in that of la Bastide. The former he believes to be unparalleled amongst ancient or modern lavas for the length and slenderness of its stream, shewing a surprising liquidity, which he illustrated by some experiments on the powers of melted iron solidifying in narrow channels.

A series of specimens illustrating the paper had formerly been presented to the Society.

2. Geological Notices. By Dr Fleming.

(1.) *Additional example of Diluvial Scratches on the Rocks in the neighbourhood of Edinburgh.*

The author stated that, recently, an opportunity had presented itself of observing, at a newly-opened sandstone quarry, *dressed and scratched surfaces*, at an elevation above the level of the sea greater than any examples of the same kind of diluvial action as yet recorded, as occurring in the neighbourhood. The locality is eastward of the east Cairn Hill, in the Pentland Hills, at a place termed "Thomson's Walls," and its elevation, according to Knox's map of Mid-Lothian, is 1400 feet.

Dr Fleming then stated, that, last autumn, in addition to the example of a dressed and scratched surface 130 yards westward of Granton Pier, *on a level with the beach*, he had observed a similar occurrence at the east side of the harbour of North Berwick, near the "Auld Kirk," on the surface of a rock of amygdaloid; and added, that he had found similar scratches, at the sea-level, on the south side of Montrose Basin.

The author next adverted to an example of dressed vertical surfaces, with *horizontal* scratches, on the northern base of North Berwick-Law. He likewise referred to the horizontal scratches on a vertical face of rock recently exposed at the Hadderwick Lime Quarries, north from Montrose.

Dr Fleming next called the attention of the Society to the Blackford Hill example of a dressed and scratched surface, and intimated that the scratches had a dip to the eastward, reaching, in some cases, to 50°. He stated it as probable, that the phenomena, instead of having resulted from diluvial action, had been produced by the abrading operations of the Braid Burn.

Verbal Notice.

(2.) *On the Fluor-Spar of Aden.*

Dr Fleming exhibited to the Society several beautiful examples of quartz and calcedony, in the form of cakes or circumscribed stalagmites, from the fort of Aden in the Red Sea, which had been

sent to him by Dr Buist of Bombay. They were remarkable as having a few minute crystals of fluoride of calcium, the matter of which aggregated during the evaporation of the water, which had furnished, in greater quantity, the siliceous materials forming the support.

The following Gentleman was duly elected an Ordinary Fellow :—

James Tod, Esq., W.S.

The following Donations to the Library were announced:—

Ordnance Survey. Account of the Measurement of the Lough Foyle Base in Ireland. By Capt. William Yolland. 4to.—*By the Honourable Board of Ordnance.*

Natural History of New York. Botany. By John Torrey. Vol. I., Part 2. Vol. II., Part 2. 4to.

Do Do. Agriculture. By E. Emons. Part 5. 4to. —*By the State of New York.*

Flora Batava. Parts 148 and 149. 4to.—*By the King of the Netherlands.*

Journal of the Asiatic Society of Bengal, No. 183. October, 1847. 8vo.—*By the Secretaries.*

A Collection of Fossil Plants from the Newcastle Coalfield.—*By Sir G. S. Mackenzie, Bart.*

Monday, 7th February 1848.

Sir THOMAS MAKDOUGAL BRISBANE, Bart., President, in the Chair.

The following Communication was read :—

1. On the Preparation of Kreatine, and on the amount of it in the flesh of different Animals. By Dr Gregory.

After some remarks on the present state of animal chemistry, the author commenced by giving a brief account of the recent discoveries of Liebig in regard to the constituents of the "juice of flesh," or the liquid contained in the substance of the muscles, which is distin-

guished from the blood by the large proportion of free acid it contains. This remarkable animal fluid has been found, by Liebig, to contain phosphoric and lactic acids in large quantity, inosinic acid in small proportion, and some other acids not yet studied; also, potash in large quantity with a little soda, a considerable proportion of magnesia, and a little lime, chloride of potassium, with a little chloride of sodium, and, besides some compounds of animal origin not yet investigated, the new base Kreatinine, and the very remarkable substance, Kreatine, first discovered by Chevreul, but in vain sought for by Berzelius and other chemists.

He then described the process, essentially that of Liebig, by which kreatine is extracted from the flesh of quadrupeds, birds, and fishes, in all of which hitherto tried, it has been found, although in small and variable quantity. A table was exhibited, shewing the percentage obtained from different kinds of flesh and fish, and the result was, that this interesting substance may be most easily and cheaply prepared from fish, especially cod, herring, salmon, and mackerel, all of which yielded much more than beef or horse-flesh, and nearly as much as fowl, which was the most productive. The maximum proportion of kreatine was 3·2 per 1000 parts of flesh. The average about 1·5 per 1000.

The author stated that he had found inosinic acid only in the flesh of fowl and turkey; and he is informed, by Baron Liebig, that it is quite possible that this acid may also have been confined to the flesh of fowls in his experiments, as it was often absent, although he cannot now ascertain the cases in which it was present.

He concluded by stating, that as kreatine is found in the urine, along with kreatinine, it appears to be, in part at least, a substance intended for excretion. Its crystalline character renders this probable; and, at all events, if it has any function to perform in the body, that function is not yet known. It must be regarded, in the mean time, as one of the numerous series of less complex products derived from the decomposition, in the body, of the effete tissues; and although we cannot yet produce it artificially, yet, from the rapid progress recently made in the study of the products of decomposition of the albuminous substances, we may hope soon, not only to do this, but also to discover, from these products, the true formulæ of the albuminous compounds.

2. Notices of a Flood at Frastanz, in the Vorarlberg, in the Autumn of 1846. By William Brown, Esq.

The author noticed the general effects of running water, in dissolving, rubbing down, and transporting to a lower level, the solid parts of the earth's surface; and referred to the gradual change which it is producing on the relative level of sea and land. He then described an occurrence which he had witnessed in the Vorarlberg, during the autumn of 1846.

After a hot and dry summer, a succession of heavy rains for nearly a fortnight, swelled all the streams flowing into the river Ill, flooded the lower grounds, and inflicted a great deal of injury on the fields, roads, and bridges. At Frastanz, a small stream brought down from the mountains an enormous quantity of gravel, which continued for at least three weeks after the rains had ceased. When first seen by him, on the 6th of September, the volume of water in the stream was not very great, nor was its velocity unusual; but immediately beneath the surface of the water, which was quite transparent, innumerable stones were seen to be in motion. These stones were generally of the size of an egg. The quantity of gravel brought down was so great, that the bed of the stream was elevated to the height of 25 feet in one part. The village of Frastanz was considered to be in danger, from this curious torrent of stones rolled along by the water; and several hundreds of men were employed to bank it in by large trees laid lengthwise, and supported by strong posts driven into the ground. In the course of the following year, a wooden canal was formed in the lowest part of the stream, by which about a third of the mass of gravel has been washed down. This has raised the level of the Ill, into which the Frastanz stream flows, for two or three miles. The quantity of loose stones in the upper part of the ravine is still so great as to threaten a renewal of the catastrophe at any time when an unusual flow of water shall set it in motion.

3. Contributions to the Phenomena of the Zodiacal Light. By Professor C. Piazzi Smyth.

The purport of this paper was to place on record certain observations made during the years 1843–4–5, in the southern hemisphere,

at those times of the year when the Zodiacal Light cannot be seen in the Northern hemisphere; to test, by means of these new data,—which, besides the novelty of the geographical position, had the further one of being determined by instrumental measurement,—what laws of the phenomena may be considered to have been satisfactorily made out, and what required further elucidation; and to recommend these latter to the attention of observers situated in more favourable parts of the world than those commanded by European Observatories generally.

After discussing the history of the subject, and mentioning the results arrived at by different observers, the author mentions the manner in which his attention was first particularly directed to the subject, describes the particular course of observation which he then commenced, and which consisted principally in observing the right ascension and declination of the apex of the light, by means of a small equatorial instrument of particular construction, which gave results not affected with more than 2° of probable error. Combining his own observations with those of former investigators, the author concludes, that the hypothesis proposed by Cassini, and subsequently maintained by La Place, Schubert, Poisson, Biot, and Humboldt, viz., that the Zodiacal light is in the form of a ring encircling the sun, is decidedly untenable, but that it is rather, as first suggested by Mairan and since affirmed by Olbers and Sir John Herschel, in the form of a lenticular mass. Mairan's idea, too, of the body being excentrically disposed about the sun, being endued with a rotation, and occasionally crossing the earth's orbit, seems to be confirmed. But the exact quantity of such excentricity, the period of rotation, the position of the plane of the body, the question of any actual periodical increase in the size and brightness of the Zodiacal light, and the physical nature of that light, whether entirely reflected, or whether, as rendered probable by some observations, partly direct, are matters, for the satisfactory determination of which more data are required. For the assistance of those who may be inclined to prosecute the inquiry, the author adds descriptions, both verbal and pictorial, of what the Zodiacal light is like, what observers may expect to see; and mentions the times of the year at which, in different latitudes, the phenomenon may be best seen, together with a number of other attendant circumstances which are necessary to be complied with, in order to procure undeniable observations.

The following Donations to the Library were announced:—

Observations made at the Magnetical and Meteorological Observatory at St Helena. Vol. I. 1840–43. 4to.—*By H. M. Government.*

Fusinieri (A.) sulle Ipotesi del Signor Melloni circa il Calore Raggiante. 4to.—*By the Author.*

Astronomical Observations made at the Royal Observatory, Edinburgh. By the late Thomas Henderson. Reduced and Edited by C. P. Smyth. Vol. VII. for 1841. 4to.—*By the Royal Observatory.*

Fellenberg (L. R. de), Fragmens de Recherches comparées sur la Nature constitutive de différentes sortes de Fibrine du Cheval dans l'état Normal et Pathologique. 8vo.

—— Analyse de l'Eau Minérale de Weissenburg. 8vo.

——Ueber die bei der Consolidation des Faserstoffes stattfindenden Veränderungen der elementar-analytischen Bestandtheile desselben. 8vo.—*By the Author.*

Bulletin des Séances de la Société Vaudoise des Sciences Naturelles. No 13. 8vo.—*By the Society.*

Journal of the Royal Geographical Society of London. Vol. XVII., Part 2. 1847. 8vo.—*By the Society.*

The London University Calendar for 1848. 12mo.—*By the University.*

Acta Academiæ Cæsareæ Leopoldino-Carolinæ Naturæ Curiosorum. Vol. XXI., Pars 2. 4to.—*By the Academy.*

Monday, 21st February 1848.

RIGHT REV. BISHOP TERROT, V.P., in the Chair.

The following Communications were read:—

1. Practical Illustration of the Adjustments of the Equatorial Instrument. By Professor C. Piazzi Smyth.

The object of this paper was partly to introduce to the notice of travellers and residents in tropical countries, a small equatorial instrument, specially contrived for observing the Zodiacal light; and partly to bring forward before amateur astronomers, prominently,

the advantage of equatorial mountings in general; as well as to exemplify the best and easiest methods of adjusting and rectifying the instruments, and placing the telescopes in every respect in the most favourable circumstances for yielding good results. After describing how, in the history of astronomy, equatorial or parallactic stands were twice taken up and abandoned again, from the erroneous estimate formed of the purposes to which they were adapted, the author mentioned the impracticable nature of the altitude and azimuth mountings which followed; and dated the present era of the perfection and the rational employment of equatorials to have commenced in 1820, when Sir J. Herschel, in conjunction with Sir J. South, erected one of these instruments, to give, by its A. R. and Declination circles, absolute places roughly; and, by means of a micrometer applied to the focus of the telescope, small differences very exactly: the old error having been, to attempt to determine absolute places with the utmost precision.

After particularising the various merits and imperfections of the two grand divisions of equatorials, viz., the English and the German, and mentioning a new construction in progress for the Edinburgh Observatory, combining with the single-pier and short polar axis of the German form, the advantage which the English possesses, of large circles, and a position for the telescope *between* the two bearing ends of the polar axis, together with an exceeding degree of firmness and stiffness,—the author proceeded to describe the six errors of adjustment to which all equatorials are subject, and to shew, by means of a model placed within a representation of the celestial sphere, contrived for the purpose, how all the rectifications might be made by means of observations of stars.

The application of clock motion to equatorials, for the purpose of keeping a celestial object stationary in the field, was next entered into; and the plan explained by which the hitherto ungovernable fits of "knocking" of the revolving balls in the later form of English clocks, has been remedied in the case of the Edinburgh Equatorial;—viz., by having *three* pendulum-balls 120° *apart*, attached to the vertical spindle of the governor, instead of only *two* at 180°.

As a proper micrometer to be used for very faint objects, in place of the ring micrometer,—which the author unhesitatingly condemned, as never having furnished accurate results either in A. R. or Decl., but more especially in the latter, in any person's hands, though so

strongly recommended, and extensively used, on account of the beauty and truth of one of the theoretical principles involved in it,—he recommended a bar-micrometer, wherein right ascensions were measured by transits across three parallel bars, marking both the immersions and emersions, so as to get rid of error of focus and irradiation of light; and declinations were measured by a bar at right angles to the former, the objects being bisected alternately with either edge of the bar. Observers already provided with position-micrometers might easily have some of these bars inserted, which in one position might be used for A. R., and in another for Decl. Such a micrometer has been found to require no illumination on the darkest nights, even in telescopes of small aperture, and to produce results, with the amorphous masses of faint comets, almost equal in accuracy to those obtained from stars observed with fine wires in an illuminated field.

The paper concluded with a short special description of the Zod. Light-equatorial, which, for economy, lightness, and general effectiveness, seemed well fitted for scientific travellers.

2. On the Vertebral Column, and some Characters that have been overlooked in the Descriptions both of the Anatomist and Zoologist. By Dr Macdonald.

After noticing that the vertebral skeleton has usually been compared to a column, of which the basis (in man) is formed by the sacrum and coccyx, the shaft or columnar part being the bodies of the true vertebræ, as they are usually styled, and surmounted by the splendid composite capital the cranium, the author proposed restricting the observations to the columnar portion, usually divided into 7 cervical, 12 dorsal, and 5 lumbar vertebræ. This division was denounced, and beginning at the summit, he shewed that the upper or cervical region consisted only of 6 vertebræ, as the 7th, in its normal position in the mammal class, had a rib partly articulated to its body, and therefore acquired the character of a dorsal vertebra.

Restricting the cervical to six, the arrangement of the atlas and axis indicates the tendency to a combination into pairs in the course of the vertebral axis. The body of the atlas is almost entirely replaced by the intrusion of the odontoid process of the axis; and thus,

by their combined form and articulations, the head resting on them is provided with an equatorial and azimuth motion, as the astronomers say. The pairing of the 1st and 2d osteologically, is further strengthened neurologically, which is also applicable to the next pair of the 3d and 4th. These two pairs are more properly to be considered as the acostal cephalic portion, as the cervical plexus is principally distributed to the upper region of the body, as far as the motosensory part of the system is concerned, although it also contributes to the thoracic and abdominal portions of the nutrient or splanchnic system. The third pair, formed by the 5th and 6th cervical vertebræ, are the acostal constituents of the humero-brachial regions, and with the 7th, 8th, 9th, and 10th, are neurologically connected together in supporting the nerves, forming the brachial plexus as they emerge from the spinal canal. This arrangement completes the cervical region in all the mammals except the *Bradipus tridactylitis;* which is also illustrative of the coupling or pair principle here proposed, as the additional vertebræ only form another pair. The idea of the different classes of vertebræ composing the cervical region, as proposed by De Blainville and Knox, was examined, and shewn to be incomplete, as it considered the 7th vertebra to be a class by itself. As De Blainville's view coincided with that now submitted, in separating the 7th from the upper vertebræ, it was *pro tanto* adduced in evidence; but the most striking corroboration was found in the examination of the skeletons of many of the mammals, several of which were exhibited and demonstrated, where it was shewn that in many, if not all, mammals, the normal position of the head of the rib was opposite the intervertebral space, and that as 12 ribs require 12 spaces, there must be 13 costal vertebræ. This additional thoracic or costal vertebra is provided by the 7, which is only (in man) deprived of its costal connection possibly by the traction of the subclavian artery, which is the remains of one of the primitive reptilöid branchial arches, even here the first rib is occasionally in its normal situation, and when it is found that, in all cases, there are in man eight and generally nine of the ribs in their normal situation, and, also, that an undue share is given to the 8th vertebra, as the whole of the 1st, and part of the 2d, rib is connected to it, we are surely authorised to consider this as the normal position in all mammals. The importance attached to this osteological discovery is, that it corrects an

error in the universally assumed character of mammals, which Daubenton and Cuvier first applied, with the sole exception above noticed of the Sloth, which, however, still remains the exception to the number, while it corroborates the principle of coupling or pairing the cervical vertebræ, which is of considerable use in unravelling the cranial vertebræ, and which De Blainville speaks of as still unintelligible " to those who have been unable to elevate themselves to this kind of questions" (the signification of the skeleton transcendentally considered) "*partly* on account of the nature of their minds, and *partly* from the want of proper and sufficient subjects of contemplation."

In this view of the cervical vertebræ, there was no examination of what are known as floating or cervical ribs, first pointed out and described by Vicq d'Azyz in the Memoirs of the Academy of Paris for the year 1774, and which lately, Professor T. Bell of King's College, London, has described in the case of the Bradypus. This class of ribs ought to be regarded as quite different from the thoracic ribs; and there was a beautiful example exhibited on the table, which the kindness of Professor Goodsir enabled the author to shew to the Society, and which forms part of a series collected and described by Dr Knox, in the London Medical Gazette, some years ago. In various classes there are similar ribs, quite unconnected with, and differing from, the thoracic ribs, which are rather homotypes of the styloid process of the temporal bone, and possibly of the lower floating or the 10th, 11th, and 12th, or abdominal ribs. (?) The consideration of these, in the next part of the communication, with the exposition of the cranial vertebræ, will form a subject for a farther communication.

Having demonstrated that the 7th rib is attached to the 7th vertebra in the Mammal class, as in the Monkeys; the Carnivora, as far as examined; the Elephant, Hog, and Horse, among the Pachydermata; the Deer, Elk, Giraffe, Camel, Ox, Sheep, among the Ruminants; and the Dugong, Porpese, and Whale, among the Cetacea,—the only exception being the Seal and Walrus, in the specimens of the Barclay Museum of the Royal College of Surgeons of Edinburgh; and also having assigned a sufficient cause for the abnormal situation of the 1st rib in Man on the 8th vertebra, instead of between the 7th and 8th,—the enumeration of the cervical region will

be 6 instead of 7, as hitherto described by all systematic naturalists, who depend on organic structure for the characters of their classification.

The following Donations to the Library were announced:—

An Attempt to discover some of the Laws which govern Animal Torpidity and Hibernation. By Peter A. Browne, LL.D. 8vo.—*By the Author.*

Cambridge and Dublin Mathematical Journal. Nos. 13 and 14. 8vo. —*By the Editor.*

Journal of the Asiatic Society of Bengal. No. 184. 8vo.—*By the Society.*

Journal of the Indian Archipelago and Eastern Seas. Nos. 1, 2, 3. 8vo.—*By the Editor.*

Guyot (A.) Note sur la distribution de Roches dans le Bassin Erratique du Rhone. 8vo.

—— Note sur le Bassin Erratique du Rhin. 8vo.

—— Note sur la Topographie des Alpes Pennines, &c. 8vo.—*By the Author.*

Monday, 6*th March* 1848.

The Very Rev. PRINCIPAL LEE, V.P., in the Chair.

The Chairman, after a brief account of the Keith Foundation, presented to General Sir Thomas M. Brisbane, Bart., G.C.B., President of the Society, the Keith Prize Medal, awarded to him by the Council, for the Makerstoun Observations on Magnetic Phenomena, made at his expense, and published in the Transactions of the Society.

The Chairman also announced that the Council had also awarded, independently of the Keith Prize, a Silver Medal to J. A. Broun, Esq., in token of their sense of his merits, in conducting and superintending the Makerstoun Observations.

The following Communication was then read :—

On the Theory of the Parallel Roads of Lochaber. By James Thomson, Esq. jun., Glasgow. Communicated by Professor Forbes.

The author, after briefly stating the views of Mr Milne, and the remarks of Sir G. S. Mackenzie, gave his reasons for agreeing with the former, that the terraces were the beaches of lakes, formed by barriers across the valleys; and, with the latter, in holding that these barriers could not have been formed of earthy detritus. He then proceeded to shew that the theory of Agassiz, according to which the barriers were formed of glaciers, was the most probable yet advanced, and while it required some modification in the details to render it consistent with recently observed facts, was strongly supported by the researches of Professor Forbes, both in regard to the former existence of glaciers in our latitudes, as demonstrated in the case of the Cuchullin Hills, and in regard to the laws of the motion of glaciers, as developed in Professor Forbes's papers on the Glaciers of the Alps.

He pointed out that all the difficulties of the theory of earthy barriers were connected with the notion of their being composed of earthy detritus, and that both Sir T. D. Lauder and Mr Milne admitted the great difficulty of accounting for their disappearance.

He then explained the modifications which were required to render the theory of Agassiz capable of explaining all the facts hitherto observed.

The highest shelf in Glen Roy stops short just above the opening into Glen Glaster, and this would have been the result had the barrier which formed that shelf blocked up Glen Roy above the latter glen, and thus forced the water to be discharged by the water-shed at the head of the valley of the Spey. It must also have blocked up Glen Collarig nearly to the Gap. To form the middle shelf, this barrier had only to retire a little, so as to open up Glen Glaster, when the water would discharge itself by the ancient river-course leading from the water-shed in Glen Glaster, first pointed out by Mr Milne.

The lowest shelf would be formed when the glacier retired to near the mouth of Glen Spean.

The blockage of Glen Gluoy seems to have been unconnected with that of the other glens. The author ascribes it to a glacier occupying the site of Loch Lochy, and fed from the high mountain to the north. He explains the occurrence of a lower shelf in Glen Gluoy, which stops short of the mouth of the glen, by a reference to analogous phenomena observed by Professor Forbes in the Lac de Combal.

The shelf in a glen near Kilfinnan observed by Mr Darwin, is accounted for by the glacier supposed to have occupied the site of Loch Lochy.

Mr Milne objects, to the notion of a glacier descending from Ben-Nevis, and crossing Glen Spean to block up Glen Roy, that the inequalities of the intervening ground are so great as to render the existence of a glacier in this direction highly improbable, more especially as the ice had a comparatively easy outlet northward towards Fort-William.

The author, however, endeavours to shew, that, if we assume a climate intermediate between that which produces the glaciers of the Alps, and that which forms the glaciers of the arctic and antarctic regions, there is no real difficulty in imagining the existence of a great expanse of ice descending from Ben-Nevis, at a level considerably higher than that of the intervening hills, as well as of the highest shelf in Glen Roy.

That such a climate may very probably have existed, the author considers as proved by the researches of Professor Forbes among the Cuchullin Hills, the elevation of which is much less than that of Ben-Nevis.

There is, in the phenomena of the great erratic blocks of the Alps, proof of the former prodigious horizontal extension of glaciers, although, in the existing climate of the Alps, the glaciers no longer exhibit the same horizontal development. The author also referred to the indications of glaciers found in many parts of Great Britain, some of them in the Lochaber district, to the occurrence of organic remains of an arctic character, and to the marks of the supposed action of icebergs, as supporting the view of the existence of a glacial climate at some remote period.

The diluvial theory of Sir G. S. Mackenzie was briefly examined, and certain objections urged against it.

The author also alluded to the objection urged by Mr Lyell to the glacial theory, on the score of the changes of relative level on sea

and land; and denied that there was any evidence of such changes having occurred since the termination of the supposed glacial period.

The paper was illustrated by a large map of the district of Lochaber, enlarged from that of Sir G. S. Mackenzie.

The following Gentlemen were duly admitted Ordinary Fellows:—

Dr James Allan, Deputy Inspector of Hospitals.
John Hall Maxwell, Esq. of Dargavel.
Thomas Stevenson, Esq., Civil Engineer.

The following Donations to the Library were announced:

Lalande's Catalogue of Stars. 8vo.
Lacaille's Catalogue of Stars. 8vo.—*By the British Association.*
The Journal of Agriculture, and Transactions of the Highland and Agricultural Society of Scotland. No. 20, March 1848. 8vo. —*By the Society.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. II. 1847-8. No. 32.

Sixty-Sixth Session.

Monday, 20*th March* 1848.

Dr CHRISTISON, V.P., in the Chair.

The following Communications were read:—

1. On an Instrument for measuring the extensibility of Elastic Solids. By Professor Forbes.

This instrument is almost a faithful reproduction of S'Gravesande's apparatus described in his "Physices Elementa Mathematica," 1742 (but not in the previous editions). It is described or alluded to by few modern writers, except Biot in his "Traité de Physique." It consists of a strong wooden table or frame, with a vice at each end, between which a wire or lamina may be stretched with a determinate tension by means of a weight attached by a cord, passing over a pulley in the manner of the musical apparatus, called a Monochord. After the tension is adjusted, both vices are screwed fast, the space included between them being exactly 50 inches. If now, any deviation of the middle point of the wire included by the vices be made (similar to the action of sounding a harp-string), the force required to pull it a certain distance aside will depend, 1*st*, on the length of the wire; 2*d*, on its tension; 3*d*, on its extensibility, or the modulus of elasticity.

S'Gravesande employed his apparatus to verify Hooke's law, that the extension is as the extending force within the limits of perfect elasticity. But it does not seem to have occurred to him, nor (singularly enough) to later experimenters, to deduce from the forces required to produce given deviations, the specific extensibility, or what Dr Young calls the *Modulus of Elasticity* of the body.

It is essential that the deviation from the rectilinear position of the wire should be ascertained with great nicety, and S'Gravesande's contrivance effects this in a very neat and satisfactory way. A fine steel chain attaches by a hook to the middle point of the extended wire, the other end being secured to the circumference of a nicely centred wheel. Another chain attached similarly to the wire of the same wheel, has a scale attached to it, a weight placed in which causes the wheel to revolve, and by means of the first chain and hook, pulls the wire out of the straight line. A long index fixed to the same axis with the wheel, points out the deviation on a much magnified scale, referred to a divided semicircle of brass. Thus a weight being placed in the scale, the corresponding deviation is instantly shewn.

Let P be the weight in the scale, D the deviation of the wire, s = *half* the length of the wire between the vices; it was proved in this communication that,

$$P = 2\,T\,\frac{D}{s} + M\left(\frac{D}{3}\right)3$$

where M is the *modulus of elasticity*, measured in grains which is easily reduced to the equivalent length of a similar wire or lamina, according to Dr Young's definition. This is on the supposition that Hooke's Law of Elasticity (the extension is as the extending force) is correct; and that law is verified if the term $M\left(\frac{D}{s}\right)^3$ be found for the same wire practically to vary as the cube of the deviation. The value of M, the modulus, is also at once given by a single observed deviation, the tension being known.

A small correction in the value of P is to be made, for the weight of the wire deflecting it from a straight line. This small correction had not escaped the notice of S'Gravesande when he verified Hooke's law.

Example.—A steel pianoforte wire, tension 50,000 grains = T; s = 25 inches.

Values of D.	Values of P.	$2\,T\,\frac{D}{s}$	$M\left(\frac{D}{s}\right)^3$
·25 inch	1100 grains	1000	100
·50 ...	2720 ...	2000	720
·75 ...	5400 ...	3000	2400

The numbers in the last column should vary as the cubes of those in the first, or be as 1, 8, 27. If we deduct 10 grains from each of them for the action of the weight of the wire depressing itself, we shall have these numbers—

90	710	2390

dividing respectively by 1, 8, and 27,

90	89	88·5

Hence the mean result for $M\left(\frac{D}{s}\right)^3$ for $D = \cdot 25$, or $\frac{D}{s} = \frac{1}{100}$, is nearly 89 grains, consequently,

$$\frac{M}{(100)^3} = 89$$

and $M = 89{,}000{,}000$ grains.

But a foot in length of the wire in question weighs 11 grains. The equivalent modulus of elasticity is therefore very nearly 8,000,000 feet of the wire in question, which agrees closely with the received numbers for steel-wire.

2. On the Anthracite of the Calton Hill. By Dr Fleming.

The occurrence of anthracite in this locality has been noticed and recorded by several observers, who seem to have overlooked some of its more remarkable peculiarities. At present, this mineral may be detected in a series of anastomosing vertical veins of calcareous spar, including, at the same time, angular portions of the claystone porphyry in which they are situate, on the upper north walk on the north side of the Observatory. The anthracite occurs, 1. In rounded, drop-like pieces, on which the calcareous spar has been moulded, not unlike the colophonite of Norway. 2. In masses with plane surfaces, apparently produced by the laminæ of the surrounding spar. 3. In angular masses, with sharp edges, and a conchoidal fractured surface. The drop-like pieces must have been solid previous to the solidification of the spar, while the flattened masses have yielded to the pressure of its crystallization. The angular masses, however, which are the most numerous, occur crowded together, of different sizes, while the neighbouring fragments unequivocally indicate, by their corresponding shape, that they had been broken when in a hard state, and separated in the very spot they now occupy, being suspended in the calcareous parts which afterwards

became spar. The author exhibited analogous examples of fractures and separations in the Beryl and Tourmaline.

The author next adverted to the opinion, that the Calton was a mass of trap which had burst through the coal formation; and that the anthracite was the altered bitumen, which the rising trap had enveloped in its passage. But, in opposition to these views, although countenanced by Jameson, Cunningham, and Milne, he stated that the Calton, with the exception of its two small *trap dykes*, consisted of a series of sedimentary matters or strata, which had been assorted by water; and that, in position, these strata occupied a place far below the mountain limestone, as is demonstrated by their dip and connection with the group extending under the coal measures from the Castle Hill to Joppa, which he had no hesitation in referring to the old red sandstone.

3. On some Phenomena of Capillary Attraction observed with Chloroform, Bisulphuret of Carbon, and other Liquids. By Dr George Wilson.

The object of this communication was to bring before the Society some phenomena which are exhibited when certain liquids, denser than water, are exposed, while contained in glass or porcelain vessels, to the alternate action of acids and alkalies. The liquids with which the phenomena described were noticed, were chloroform, bisulphuret of carbon, Dutch liquid (C^4 H^4 Cl^2), bromine, oil of cloves, of sassafras, of cinnamon, and of bitter almonds. The majority of the experiments were made with chloroform, and the phenomena presented in common by all the liquids mentioned were described in full, as presented by chloroform.

When that fluid is dropped into water, contained in a glass or glazed porcelain vessel, it falls to the bottom as a brilliant, highly mobile globule. If potass, soda, or ammonia, be now added, the globule at once collapses, sinks as if pressed down by the alkali, and flattens out on the bottom of the containing vessel. On slightly supersaturating the alkali with an acid, the flattened chloroform recovers, with great rapidity, its globular shape, as if suddenly relieved from pressure.

When the acid in its turn is supersaturated with alkali, the flattening again occurs; and by alternating the addition of these re-agents, the same globule may be successively flattened and rounded for any number of times.

If the experiments referred to be made with quantities of chloroform sufficiently large to touch the walls of the containing vessel on every side, and to form a stratum of some depth, the effect of adding alkaline water is to give the chloroform a surface apparently horizontal, and the addition of acids makes its upper boundary highly convex.

Change in configuration, however, is not the only alteration which the globule of chloroform undergoes. Several of its physical properties are strikingly modified by its contact with aqueous solutions of acids and alkalies. When these are alternately made to act on chloroform at the bottom of a flat white porcelain vessel, which admits of the resulting phenomena being distinctly observed, the reagents in question change the sensible characters of the denser liquids in the following way. Under acidulated water the globules are brilliant, very mobile, and obedient to the solicitation of gravity. Detached globules, when they meet, readily run together, and scarcely one is to be seen without a bubble of air attached to its upper surface, and adhering tenaciously. Under alkaline water, on the other hand, the globules of chloroform spread out into flat discs, with rounded edges; or elongated into irregularly ovoidal or flattened cylindrical forms, which vary their shapes on the slightest impulse. These flattened globules are, moreover, much less mobile than the rounded ones under acid. They move sluggishly, cling to the vessel, and leave a tail behind them when urged to move rapidly. Their brilliancy is sensibly diminished, and no air-bells adhere to their upper surfaces.

Chloroform admits of being coloured by digestion on litmus, alkanet root, &c. &c. Globules of the coloured liquid flatten out greatly more under alkalies than the colourless chloroform does, so that blue or red globules spread over an irregular area five or six times greater than they occupy under acids. Their apparent viscidity, loss of mobility and of brilliancy, are also more marked than when colouring matter is absent.

Phenomena similar to those noticed with the colourless chloroform were observed with the several liquids previously mentioned. The author, in conclusion, declined to enter on the theory of the phenomena described, further than to ascribe an important share in their production to the action of lighter and heavier liquids on each other.

The following Gentlemen were duly elected Ordinary Fellows:—

Henry Davidson, Esq.
Rev. J. Hannah, M.A.

The following Donation to the Library was announced:—

First Report on the Coals suited to the Steam Navy. By Sir Henry De la Beche and Dr Lyon Playfair. Fol.—*By Sir Henry De la Beche.*

Monday, 3d April 1848.

Sir THOMAS MAKDOUGALL BRISBANE, Bart., President, in the Chair.

The following Communications were read:—

1. Notice of the Orbit of the Binary Star *α* Centauri, as recently determined by Captain W. S. Jacob, Bombay Engineers. By Professor C. P. Smyth.

The object of this paper is to point out the extremely important and interesting characteristics of the orbit of the two stars of *α* Centauri round their centre of gravity, with the object of procuring as many observations as possible from southern observers during the periastral passage in 1851·5.

Professor Henderson and Sir J. Herschel, the only two observers who had specially applied themselves to the subject previously to Captain Jacob, were not able to make any thing of it, with such materials as had been accumulated up to their time. They merely ventured to predict, that a very close affinity of the two stars might be expected about the year 1867; and both seemed to consider that the period of revolution was something very great,—that the star was increasing in distance at the time that it was observed by Lacaille in 1751, and by Maskelyne in 1761; and that it had occupied the intervening time in reaching its maximum distance, without any sensible change of angle of position.

Sir J. Herschel, in concluding his review of the subject, said, "that no subject more worthy of continued and diligent attention could possibly be urged on the attention of southern astronomers;" and this has since been most eminently borne out by Captain Jacob's obser-

vations, which, beginning about the time that Sir John left off (1838), have been continued up to the present year. All the conclusions, indeed, ventured on by former authorities have turned out erroneous; but the close approximation to the truth now obtained exhibits far more interesting features than were ever expected. At the epochs of Lacaille and Maskelyne, the distance was on the decrease, instead of the increase; and the stars were seen in almost exactly the same relative position by the latter observer in 1761, as by Sir J. Herschel in 1838; and in the interval they had, instead of merely gaining the aphastre without sensible change of angle of position, really made a whole revolution, and altered that angle by 360°. The period is about 77 years; the mass three-fourths of the solar; the greatest distance 22″·5, the least distance 0″·5; and the periastre takes place in 1851·5, when, on account of the excessive excentricity of the orbit, the change of angle of position will be actually 2° 40′ per day.

That will, therefore, be a most crucial period for testing the theory by observations of the facts; and affords the very best and strongest instance for it of all the double stars yet discovered; in addition to which, the accurate determination of the parallax of the star by Professor Henderson gives it a crowning importance.

2. On the Colouring Matter of the *Morinda citrifolia*. By Dr Thomas Anderson.

The substance examined by the author was imported into Glasgow from Bombay, under the name of sooranjee, as a substitute for madder, but had been found useless by the dyers. No information could be obtained regarding its botanical origin in this country, but the importers having written to their correspondents received a quantity of seeds, labelled, Seeds of the Sooranjee plant, *Morinda citrifolia*. These seeds did not germinate, but agreed in their characters with those of *M. citrifolia*; and, for reasons stated at length in the paper, are considered by Dr Balfour to belong to that plant.

The colouring matter to which the author applies the name of morindine, was extracted from the bark of the root by boiling alcohol, and purified by successive crystallizations, and finally by solution in boiling spirit, acidulated with hydrochloric acid, which was found necessary for the separation of the last traces of ash. It then was in the form of minute acicular crystals of a fine yellow colour.

and satiny lustre, sparingly soluble in water, and in cold alcohol, but much more so in boiling dilute spirit, from which it is deposited on cooling, and insoluble in ether. It dissolves in alkalies with a fine red, and in sulphuric acid with a violet colour, and is decomposed by heat with the production of a crystalline sublimate. The analysis gave the following results:—

Carbon, .	55·46	55·40	55·39
Hydrogen, .	5·19	5·03	
Oxygen, .	39·35	39·57	
	100·00	100·00	

From which the author deduces the formula $C_{28}\ H_{15}\ O_{15}$, which differs from that of sublimed madder purple, the probable formula of which is $C_{28}\ H_{16}\ O_{16}$, by a single equivalent of water only. It approaches very closely in many chemical characters to the madder colouring matters, but differs from them in its relations as a dye. For the author had found that it was incapable of producing colours with alum and iron mordants, but with turkey-red mordant it produces a dark red.

By the sublimation of morindine, the author obtained another substance, to which he gives the name of morindone, in the form of fine red needles of considerable length, and which is insoluble in water, both hot and cold, but soluble in alcohol and ether. It dissolves also in alkalies with a magnificent purple colour, and in strong sulphuric acid, with the same colour. The author had been able to make only an imperfect analysis of this substance, the results of which approximated to the formula $C_{28}\ H_{10}\ O_{10}$, and should this be confirmed, would differ only from madder red by a single equivalent of water, and be a polymeric of gentianine.

The author concluded by remarking that morindine formed the type of a new class of colouring matters, fixing only on turkey-red mordant, which would, in all probability, throw some light on the obscure subject of the theory of turkey-red dyeing.

3. An Attempt to improve the present Methods of determining the Strength and Direction of the Wind at Sea. By Professor C. P. Smyth.

The laxity of the present methods having been brought, by his friend Captain Cockburn, R.N., before the author, with a desire to

be furnished with some sort of anemometer, and with some easy means of eliminating the effect of the motion of the vessel, he began to consider what would be the *most appropriate* form of anemometer to be used at sea; for several kinds had been already tried, but had failed, as he thought, from not being constructed on a suitable principle. The species which the author considered the best, was that which should imitate, as nearly as possible, *mutatis mutandis*, the log-line by means of which the ship's way through the water is determined; for that instrument seems to have preserved its situation and supremacy over all others on board-ship amongst all nations, and from the time of Columbus to the present, mainly on account of the appropriateness of the principle involved. After describing several means by which the principle might be imitated to different degrees, the preference was given to Mr Edgeworth's anemometer, in which a horizontal wheel, armed with hemispheres on the end of each spoke, revolves in the *same direction*, from *whatever quarter* the wind may blow; and the centre of each cup moves at one-third the velocity of the current, by reason of the greater force of the wind on the concave than on the convex side. A series of experiments was entered on to determine the best shape and size to give the machine in practice, and the result at length arrived at was exhibited on the table, in the form of an anemometer with four horizontally revolving arms, on the ends of which were hemispheres, each four inches in diameter, with a radial distance of six inches. An endless screw on the vertical axis of this revolving part gave motion to a train of wheels which served to count the number of revolutions made in a given time. A weight of 1½ grains in the centre of one of the cups, was found sufficient to overcome the resistance to motion.

Some experiments were described which seemed to shew that the instrument could be fully depended on, and that the *strength* or *velocity* of the wind at sea might now be always entered in the log-book, as being of so many knots per hour, instead of in the usual unmeaning manner; and as the vanes actually used in ships give the *direction* of the wind with sufficient accuracy, all the elements necessary for eliminating the effect of the motion of the ships, or for deducing the true wind from the apparent one, may be assumed as being attainable, but the description of the practical method proposed for adoption was deferred for the next Meeting.

The author next described the problem of determining the true wind from the observed motion of the vessel and the apparent wind, as being merely a special instance of the general theorem of the parallelogram of forces, the course of the ship being one side; the apparent wind, the diagonal; and the true wind, another side; so that the case might always be reduced to the calculation, according to the usual rules for plane triangles, of the third side and one of the angles of a triangle, from the two other sides of their included angle, excepting in the simpler conditions of going exactly with or against the wind.

But as the calculations in this way, though easy enough, threatened to be uselessly and overpoweringly burdensome, considering the enormous number of cases which would have to be computed in any voyage, the small degree of accuracy required, and the untoward nature, for trigonometrical calculations, of the data as observed for the ordinary purposes of navigation,—the author contrived a simple set of scales, in which, *entering* with the directions and velocities of the ship and apparent wind, as usually observed, the direction and velocity of the true wind are given at once by inspection; and might be inserted, with very little trouble to naval officers, in two appropriate columns introduced into the log-books, as kept at present.

The following Donations to the Library were announced:—

First Report on the Coals suited to the Steam Navy. By Sir Henry De la Beche and Dr Lyon Playfair. 8vo.—*By Sir Henry De la Beche.*

The American Journal of Science and Arts. Conducted by Professors Silliman and Dana. Second Series. January 1848, No. 13. 8vo.—*By the Editor.*

Bouet-Villaumez (Le Comte E.) Description Nautique de l'Afrique Occidentale. 8vo.

Petit-Thouars (Abel du). Voyage auteur du Monde sur la Frégate la Vénus. Tom. VI., VII., VIII., IX., X. (Physique, par U. de Tessan. Tom. I., II., III., IV., V.) 8vo.

—— Atlas Hydrographique du même. Imp. Fol.

Collection des Cartes des Côtes de France. Imp. Fol. (In sheets.)

Beyat (P.) Traité de Géodésie a l'usage des Marins. 8vo.

—— Exposé des Opérations Géodésiques. 1839. 4to.

Beyat. Le même. 1844. 4to.

Jehenne (M.) Renseignements Nautiques sur Nossi-Bé, Nossi-Mitsiou, Bavatoubé, &c. 8vo.

Urville (J. Dumont d') Voyage au Pole sud, et dans l'Océanie, sur les Corvettes L'Astrolabe et la Zelée. 8vo.

Daussy (M.) Nouvelle Méthode pour calculer la Marche des Chronomètres. 8vo.

—— Table des Positions Géographiques des principaux lieux du Globe. 8vo.

Brossay (M. Chiron du). Instructions Nautiques sur l'Attérrage et la Navigation de la Platte. 8vo.

Maucroix (M. D'Estremont de). Note sur le Banc de Feroë. 8vo.

Moutravel (L. Tardy de). Instructions pour naviguer sur la Côte Septentrionale du Brésil et dans le fleuve des Amazones. 8vo.

Condé (M. de Maussion). Notice sur le Golfe de Honduras. 8vo.

Bourdieu (L. du). Notes sur quelques Ports de l'Ile de Haïti. 8vo.

Keller (F. A. E.) Des Ouragans, Tornados, Typhons, et Tempêtes. 8vo.

Périer (M. du). Notes sur l'Attérrissage du Rio de la Plata. 8vo.

Kerhallet (Charles P. de). Instruction pour remonter la Côte du Brésil. 8vo.

Jehenne (M.) Renseignements Nautiques sur l'Ile Mayotte. 8vo.

Lartigue (M.) Exposition du Système des Vents. 8vo.

Pagel (Louis). La Latitude par les Hauteurs hors de Méridien. 8vo.

Presented by the French Government, Marine Department.

Spittal (Robert), M.D., Introductory Discourse on Pathology and the Practice of Medicine. 12mo.—*By the Author.*

Journal of the Statistical Society of London. Vol. II. Part 1. March 1848. 8vo.—*By the Society.*

Monday, 17th April 1848.

DR CHRISTISON, V.P., in the Chair.

The following Communications were read:—

1. On the Action of the Dry Gases on Organic Colouring Matters, and its relation to the Theory of Bleaching. By Dr George Wilson.

This communication is divided into six sections. In the first, the author states that the object of his paper is to supply a defect in the

theory of chlorine-bleaching, by endeavouring to explain why the removal of water from that gas arrests its bleaching action. In the preliminary discussion, he refers at some length to Davy's theory, that moist chlorine does not bleach directly, but only in a secondary way, by combining with the hydrogen of the associated water, and liberating the oxygen, which is the true bleacher. After pointing out the untenable assumptions and self-destructive arguments on which this theory is built, the author proceeds in the second section, which discusses the influence of sunlight on the bleaching action of dry chlorine, to shew, that Davy's proposition that dry chlorine does not bleach dry organic colours is true, provided direct sunlight be excluded, but does not apply to the gas when exposed to the actinic influence of the sunbeam. In a comparative trial, one specimen of dry litmus paper was found to resist the decolorizing action of dry chlorine for more than eight months when kept in darkness; whilst the colour of another portion of the same paper totally disappeared after six weeks' exposure to sunshine. Another comparative experiment was not so successful as regarded rapidity of actinic bleaching; but both sets of trials led the author to infer, that darkness as well as dryness is essential to the negative action of chlorine on colours.

The third section is occupied with the record of experiments, instituted with a view to determine whether the presence of water is as essential to the bleaching action of oxygen, sulphurous acid, and sulphuretted hydrogen, as it is to that of chlorine. The general result of the trials made was, that the gases mentioned may be retained, when dry, for months over dry litmus, without decolorizing it; and that they are, therefore, at least as much dependent as chlorine on water for their power of bleaching.

The fourth section investigates, in like manner, the extent to which the acid gases and ammonia have their power to change organic colouring matters, influenced by the absence of water from the gas and the colour. The author finds that the modifying action of carbonic, sulphurous, and hydrosulphuric acids on colours, is totally arrested by the abstraction of water; and that that of hydrochloric acid and ammonia is long delayed. He infers, from the results detailed in sections third and fourth, that there is nothing exceptional or anomalous in the non-bleaching action of dry chlorine, and that it is only a particular case of a general law, applying to all gases

which affect colours, and teaching that elastic fluids, when anhydrous, lose in whole, or in part, the power to destroy or change the tints of organic bodies, which they possess when associated with water.

Section fifth reviews the methods employed for drying gases, and the tests of gaseous dryness. It enters at length into the question, how far it is possible to confer absolute dryness on an elastic fluid, and suggests some modifications of the processes at present in use, which the author thinks will prove serviceable. Non-action on colouring matter is likewise pointed out as a negative test of dryness of some value, in relation to the gases which act on colours.

Section sixth is devoted to the question, Does water accelerate the action of gases on colours, in virtue simply of its conferring mediate liquidity on the gas? The author thinks not, and refers to the slow action which he has observed of liquid anhydrous bromine and sulphurous acid on blue litmus, as contrasted with their rapid production of destruction or modification of colour when dissolved in water, as shewing that the liquefaction of the gas is not the only cause of its rapid action when moist. He contends that this is only to be fully accounted for by taking into consideration the power of water to liquefy *both* the colouring matter and the gas, and thus to bring them into a closeness of physical contact in the highest degree favourable to energetic chemical action. The author was led, in connection with this view, to infer that dry gases would act on dry colours in other liquids besides water, provided only these could dissolve both the gas and the colouring matter. He finds, however, that this cannot be laid down as a general proposition, at least so far as chlorine is concerned, the only gas on which he has had opportunity to make researches in reference to this point. The volatile oils of the type of spirit of turpentine (C 5, H 4) and chloroform, which contain no oxygen, and sulphuret of carbon, which contains neither of the elements of water, dissolve the colouring principle of alkanet root, and also chlorine, but the gas does not destroy the colour. Solutions of dry litmus, on the other hand, in chloroform and sulphuret of carbon, are instantly bleached by dry chlorine.

The author's final conclusion is, that the function of water in bleaching, speaking generally, is to dissolve the colour and the gas, and so to bring them within the sphere of chemical affinity; and that water is more efficacious in accelerating bleaching than other liquids, simply because it excels most of them in solvent power.

2. On the Products of the Destructive Distillation of Animal Substances, Part I. By Dr Thomas Anderson.

In this communication the author details the general properties of bone-oil, the substance employed in his experiments, and those of certain of the volatile bases contained in it.

The oil was first rectified, and the product collected in two separate portions, each of which was separately agitated with dilute sulphuric acid for the separation of the bases. The acid solution so obtained was then boiled down to a small bulk for the purpose of separating any non-basic oil which might have been dissolved, and distilled with potash, soda, or slaked lime. The bases passed over in solution in water, from which they were separated by means of solid caustic potass; similar processes were performed with both portions of the bone-oil, but in the present paper the author confines himself to the pure volatile portion only.

The oil separated by this process from the more volatile portion was found to be a mixture of at least four or five different bases, which were separated from each other by fractionated distillation.

The most volatile of these, which boils at about 175° Fahr., was present in extremely minute quantity only. For it the author proposes the name of petinine (from πετεινος, volatile.) It is a transparent colourless fluid, highly soluble in water, alcohol, and ether. The smell is pungent, and resembles that of ammonia, but is accompanied by the odour of decaying apples. It gives, with chloride of gold, a pale-yellow precipitate, and with bichloride of platinum and corrosive sublimate, beautiful crystallisable salts, the former resembling iodide of lead, the latter in pearly plates. The analysis of petinine gave results corresponding with the formula $C_8 H_{10} N$, which was confirmed by the constitution of the platinine salt, the formula of which was found to be $C_8 H_{10} N, H Cl, Pt. Cl_2$. The author details, as far as the minute quantity at his disposal would allow, the properties of the salts of this base.

He then takes up the consideration of that portion of the mixed basis, which distilled between 270° and 280°, which, after successive rectifications, was found to give the formula $C_{12} H_7 N$, and to agree in all its properties with the base formerly obtained by the author from coal-tar, and described under the name of picoline. Aniline

was also found present in that portion of the mixed tars which distilled above 355°, and was distinguished by its reaction with chloride of lime.

The author also mentions the existence of several other bases, the constitution and properties of which will be described in the second part of his researches.

3. Note respecting the Refractive and Dispersive Power of Chloroform. By Professor Forbes.

From an experiment made in very cloudy weather, and therefore rather unfavourable light, I determined the following indices of refraction for pure chloroform, prepared by Dr George Wilson, of sp. gr. The measure of the refracting angle of the prism was 39° 41′. References were made to the principal lines of the spectrum, as below, the temperature of the fluid was probably 54°.

Extreme red, . . .	$\mu =$ 1·4475
B (in the red), ...	1·4488
D (in the orange-yellow), . . .	1·451
b (in the green), ...	1·456
F (in the blue), ...	1·457
H (in the violet, being the least refrangible of the two groups so designated), . .	1·463
Extreme violet, ...	1·4675

Hence the refractive index is by no means remarkably great, being nearly that of wax, spermaceti, and several of the essential oils.

The dispersive power, or $\frac{\text{sp.}}{\mu - 1}$ is equal to ·045, which again agrees nearly with that of the essential oils. The high specific gravity of the body appears to have no marked influence in increasing its action on light.

The following Gentlemen were duly elected Ordinary Fellows :—

Dr Patrick Newbigging.
W. Swan, Esq.

The following Donations to the Library were announced:—

Greenwich Magnetical and Meteorological Observations, 1845. 4to. —*By the Observatory.*

Annales des Sciences Physiques et Naturelles, d'Agriculture et d'Industrie, publiées par la Société Royale d'Agriculture, &c., de Lyon. Tom. IX., 1846. 8vo.—*By the Society.*

Abhandlungen der Königl. Gesellschaft der Wissenschaften zu Göttingen. 3 Bde. 1845-47. 4to.—*By the Society.*

Philosophical Transactions of the Royal Society of London, for 1847. Part II. 4to.

List of Fellows of the Royal Society. 4to.

Proceedings of the Royal Society. 1847, No. 69. 8vo.—*By the Society.*

Proceedings of the American Academy of Arts and Sciences. January 27, 1847—January 4, 1848. 8vo.—*By the Society.*

Handbuch der Mineralogie, von J. F. L. Hausmann. Theil 2. 8vo. —*By the Author.*

Thoughts on the Principles of Taxation, with reference to a Property Tax, and its exceptions. By Charles Babbage, Esq. 8vo.—*By the Author.*

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Tom. XXIV., No. 11, to Tom. XXVI., No. 11. 4to.—*By the Academy.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. II.	1849.	No. 34.

Sixty-Seventh Session.

Monday, 5th February 1849.

Sir T. MAKDOUGALL BRISBANE, Bart., President, in the Chair.

The following Donations to the Library were announced:—

Abhandlungen der Mathematisch-Physikalischen Classe der K. Bayerischen Akademie der Wissenschaften. Bde. I., II, III., & IV., Abtheil. 1 & 2. 4to.

Abhandlungen der Philosophisch-Philologischen Classe der K. Bayerischen Akademie der Wissenschaften. Bde. I., II., III., & IV., Abtheil. 1 & 2. Bd. V., Abtheil. 1. 4to.

Die Chemie in ihrem verhältnisse zur Physiologie und Pathologie. Von D. Max. Pettenkofer. 4to.

Denkrede auf Joseph Gerhard Zaccarini. Von Carl F. P. v. Martins. 4to.

Rede bei eröffnung der Sizung der K. Bayerischen Akademie der Wissenschaften am 28 Marz 1848. Von Carl F. P. v. Martins. 4to.—*By the Academy.*

Bulletin de la Société de Géographie. Tom. IX., 3me Série. 8vo. —*By the Society.*

Journal of the London Geographical Society. Vol. XVIII., Part 2. 8vo.—*By the Society.*

Transactions of the China Branch of the Royal Asiatic Society. 1847. 8vo.—*By the Society.*

The American Journal of Science and Arts. 2d Series. Vol. VI., No. 18. 8vo.—*By the Editors.*

The Quarterly Journal of the Geological Society. No. 16. 8vo. —*By the Society.*

Memoirs of the American Academy of Arts and Sciences. N.S. Vol. III. 4to.—*By the Academy.*

The Ethnological Journal. No. 8. 8vo.—*By the Editor.*

Remarks on the Improvement of Tidal Rivers, illustrated by reference to works executed on the Tay and other rivers. By David Stevenson, F.R.S.E. 8vo.—*By the Author.*

Annales des Sciences Physiques et Naturelles, d'Agriculture et d'Industrie, publiées par la Société Royale d'Agriculture, &c., de Lyon. Tom. X. 8vo.—*By the Society.*

Annales de la Société Linnéenne de Lyon. Années 1845–6. 8vo. —*By the Society.*

Proceedings of the Royal Astronomical Society. Vol. IX., No. 2. 8vo.—*By the Society.*

Monday, February 19, 1849.

Mr CADELL in the Chair.

The following Communications were read:—

1. Abstract of a Communication on Rolling Curves.

This paper commenced with an outline of the nature and history of the problem of rolling curves, and it was shewn that the subject had been discussed previously, by several geometers, amongst whom were De la Hire and Nicolè in the *Mémoires de l'Academie*, Euler, Professor Willis, in his *Principles of Mechanism*, and the Rev. H. Holditch in the *Cambridge Philosophical Transactions*.

None of these authors, however, except the two last, had made any application of their methods; and the principal object of the present communication was to find how far the general equations could be simplified in particular cases, and to apply the results to practice.

Several problems were then worked out, of which some were applicable to the generation of curves, and some to wheelwork; while others were interesting as shewing the relations which exist between different curves; and, finally, a collection of examples was added, as an illustration of the fertility of the methods employed.

2. On the Extraction of Mannite from the Dandelion. By Messrs Smith; with an Analysis of the Mannite, by Dr Stenhouse. Communicated by Dr George Wilson.

Messrs Smith stated that they had extracted from the dandelion, a large amount of a crystalline sweet substance, having all the physical characters of mannite. It was analysed by Dr Stenhouse, and found to contain carbon, hydrogen, and oxygen, in the proportions which characterise the accepted formula for mannite; viz., $C_6 H_7 O_6$, so that it certainly was the substance it was supposed to be.

Messrs Widnmann and Frickhinger, it was stated, had anticipated Messrs Smith in the separation of mannite from the dandelion juice, and were led to believe that the mannite did not pre-exist ready formed in the dandelion; but was formed in the juice as the result of a peculiar fermentation which it underwent. This result was confirmed by the Messrs Smith, who experimented with large parcels of the plant, and found that even from quantities of the fresh root, so large as 40 lb., no mannite could be extracted, if the expressed juice were prevented from fermenting; whilst, if fermentation were permitted, the same weight of roots yielded a large quantity of mannite, which appears to be derived from the sugar, inulin, &c., of the dandelion, which were converted into mannite, gum, and lactic acid.

The Messrs Smith stated, in conclusion, that they had not been able to confirm the statement of Polex, that the dandelion contains a bitter crystallizable substance, such as he had described under the name of Taraxacine.

3. On some new Voltaic arrangements with Chlorous and Chromic Acids, with an account of a Battery, yielding electricity of great intensity, in which the negative, as well as the positive element is Zinc. By Dr Thomas Wright. Communicated by Dr G. Wilson.

The author, after referring to the principle on which the intense batteries of Daniel and Grove are constructed, and to the disadvantages connected with the use of the porous cells in those arrangements, stated that he had some time ago instituted a series of experiments, with a view to the construction of a voltaic circle of high electro-motive force, capable of being excited by a single solution, similarly to the battery of Mr Smee. Having employed a great

variety of solutions, he was led to consider mixtures of chromic or chlorous acid with dilute sulphuric acid, best adapted to the purpose he had proposed.

The chromic acid battery was arranged by twisting round one end of a cylinder of coke a copper conducting wire, soaking the part in boiling wax, and afterwards covering it with varnish, to protect the wire from the acid: the coke was then surrounded by a cylinder of amalgamated zinc, and firmly fixed in its place by wedges of varnished cork. To form the exciting liquid, a measure of strong sulphuric acid was added to an equal measure of a hot saturated solution of bichromate of potash: the mixture was then diluted with four measures of water, and set aside to cool. The coke and zinc cylinders placed in a tumbler of the solution possessed a high degree of electro-motive force, a single alternation being capable of decomposing acidulated water with platinum electrodes. The author stated, that the arrangement was not constant, its action gradually declining after immersion. But he considered that a small pair was well adapted for the excitation of electro-magnetic apparatus, from its possessing about three times the intensity of Smee's arrangement. In an experiment made by him with Dr Wilson, a series of four pairs, roughly put together in half-pint tumblers, decomposed acidulated water, at the rate of two cubic inches of mixed gases per minute with a cold, and four with a hot, charge of the chromic acid solution. No gas was evolved from the amalgamated zinc surface in either case. One of the advantages of the battery was, that a series of cylinders, however extensive, might, as in Wollaston's arrangement, be immersed and removed from the solution at once, and the energetic effects of first immersion obtained at pleasure. Platina, or boxwood charcoal might be used in place of coke: a small series of thirteen pairs (charcoal and amalgamated zinc), each exposing a surface of about a quarter of an inch square, afforded a shock equal to a Cruickshank's battery of fifty pairs of four-inch plates, a perceptible shock being even felt from four pairs.

The solution of chlorous or hypochloric acid ($Cl\ O_4$) was prepared, by pouring a drachm of powdered chlorate of potash into a wine glass containing an ounce of concentrated sulphuric acid, and in ten minutes afterwards plunging the mixture into seven ounces of water. A pair of plates (amalgamated zinc and thin sheet-brass) excited by the last solution gave a powerful current, until the chlorous acid was exhausted. The author had, however, more than once failed to ob-

tain any current from such an arrangement. A mixture of chlorate of potash and concentrated sulphuric acid formed a good charge for the negative side of Grove's double cell.

The author then proceeded to describe the platinized zinc battery. He was led to its discovery by observing that zinc (not amalgamated) has a tendency to assume an inactive state in some solutions containing a large quantity of sulphuric acid. Two or three arrangements were described, in which the negative plate consisted of zinc in various fluids, viz., dilute sulphuric acid, hypochloric acid and sulphuric acid, solution of sulphate of copper and sulphuric acid, &c. The most powerful battery of this class was formed by a negative plate of zinc included in a porous cell, containing a mixture of one measure of nitric acid with four of sulphuric acid, and associated with a double plate of zinc in a solution of potash or common salt. Such a circle was found to have an intensity equal to the battery of Professor Daniel, but by simply brushing the negative plate with a very dilute hot or acid solution of chloride of platinum, *the electro-motive force of the battery was doubled*, a single cell being then capable of decomposing water with platinum electrodes. A platinized zinc battery of three cells was placed on the table, the arrangement of the porous and outer cell being that of Professor Grove. The positive plate of each outer cell was folded over into the porous cell, and formed the negative plate of the pair next in series; there was therefore no necessity for binding screws, solderings, or mercury cups in the whole arrangement. The platinized zinc of each cell exposed a surface of 2·5 in. by 3·7 in. The series of three cells gave a cubic inch of mixed gases in 37 seconds, but the author considered that the battery would give two cubic inches of gas per minute, when the charge of the arrangement had become warm by the passage of the current. After use, the zinc plates were well rinsed in clean water and allowed to dry, and it was considered advisable to give them a slight brushing with the solution of platinum before their being again used. The platinized zinc battery was a *constant* arrangement.

The following Donations to the Library were announced:—

American Journal of Science and Arts. Conducted by Professors Silliman and Dana. Second series. Vol. VII., No. 19. 8vo.—*By the Editors.*

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. IV., Nos. 3, 4, 5. 8vo.—*By the Academy.*

Journal of the Statistical Society of London. Vol. XII., Part I. 8vo. *By the Society.*

Quarterly Journal of the Geological Society. No. 17. 8vo.—*By the Society.*

The Ethnological Journal. No. 9. 8vo.—*By the Editor.*

Journal of the Indian Archipelago and Eastern Asia. Vol. II., Nos. 9, 10, 11, 12. 8vo.—*By the Editor.*

A Monograph of the British Naked-eyed Medusæ, with figures of all the species. By Edward Forbes, F.R.S. 4to.—*By the Author.*

Monday, March 5, 1849.

The Very Rev. Principal LEE, V.P., in the Chair.

The following communication was read:—

Biographical Notice of Dr Chalmers. By the Very Rev. E. B. Ramsay.

The writer of this paper commenced by stating his purpose of viewing Dr Chalmers as a public character only, and to avoid all questions which belonged to the peculiar relations in which he stood to his own religious communion; and after a brief outline of the various circumstances of his life, and the dates belonging to each, the paper proposed to consider Dr Chalmers,—

I. As an Author.

II. As a Political Economist.

III. As a Speaker.

I. Under the first head were noted the peculiarities of Dr Chalmers's mode of treating a subject, and the distinguishing points of his style, the abundance of his *imaginative* faculty, and the effects which were produced by it upon his writings.

II. Under the head of political economy, the principal object was to exhibit Dr Chalmers as a true Christian philanthropist. The circumstances connected with his management of the poor in St John's parish, Glasgow, were detailed; and the influence which that experi-

ment had upon his views of pauperism and poor-laws, generally. Some objections to his Glasgow scheme were considered, and some misapprehensions of it were explained. Under this head were detailed his views on Ecclesiastical and Academical Endowments, and his testimony to the value of the English Church and Universities.

III. In considering Dr Chalmers as a public speaker, some specimens of his sermons were read, with remarks upon his eloquence in the pulpit. The case of his speech on the Catholic Emancipation Bill, was cited as an instance of great effect produced by eloquence at a public meeting. His striking reply to an accusation of inconsistency brought against him in the General Assembly, and a specimen of his mode of lecturing were given. Some observations were then made on his love of natural scenery, and his admiration of the beauties of the material world. His private character and social intercourse were referred to—his powers of conversation, and his perfect freedom from affectation, bigotry, or intolerance; of these qualities examples were cited, as also of his turn for humour, and his keen sense of the ridiculous. The author of the paper then concluded by stating his conviction, that although there might be differences of judgment regarding particular portions of Dr Chalmers's public acts and opinions, yet that no one who had known him personally, and who had been well acquainted with his real character—that no one who had studied and appreciated the spirit and tendencies of his writings, would hesitate to admit that he was a good and a great man—that he was a sincere friend to the poor,—and that his great aim in life was to promote the glory of God, and the wellbeing of his fellow-men—that he was a Scotchman of whom Scotland might be proud—and that his labours and his writings have gained a name, and established a reputation, which will not pass away.

The following Donations to the Library were announced:—

Catalogue of the Library of the Literary and Philosophical Society of Newcastle-upon-Tyne. 8vo.—*By the Society.*

Catalogue of the Library of the Royal College of Physicians of Edinburgh. 8vo.—*By the Royal College of Physicians.*

Journal of Agriculture, and Transactions of the Highland and Agricultural Society of Scotland. No. 24; (N. S.) 8vo.—*By the Society.*

Magnetische und Meteorologische Beobachtungen zu Prag. 1841, 1842, 1843, 1844, 1845, 1846, 1847, 1848. 4to.

Magnetische und Geographische Ortsbestimmungen Böhmen in dem Jahren 1843–5. Von Karl Kreil. 4to.

Magnetische und Geographische Ortsbestimmungen in Österreichischen Kaiserstaate. Erster Jahrgang. 1846. 4to.—*By the Observatory of Prague.*

Monday, March 19, 1849.

The Right Rev. Bishop TERROT, V. P., in the Chair.

The following Communications were read:—

1. An Attempt to compare the Exact and Popular Estimates of Probability. By Bishop Terrot.

The author began by defining probability as being that state of mind in which we are inclined to believe a proposition, without being absolutely convinced that it is true. Objectively, every proposition is either true or false; subjectively, it may be certainly true, probable, or impossible.

The measure of probability he shewed to be the same as the measure of the cause producing it; that is, the ratio of the reasons inclining us to believe a proposition, to the whole number of reasons bearing upon it, whether for or against; all of which reasons are founded, either upon necessary inference from experience, or from testimony.

How inference from experience may lead to a definite expectation of an event different from that which has been experienced, was shewn in the case of an urn, containing two balls, white or black, and from which a white has been drawn. There is then a probability of $\frac{1}{3}$ that the remaining ball will be black; and if a witness asserts that at a second drawing black was drawn, his credit must be very low indeed, if his assertion does not raise this probability from $\frac{1}{3}$ to above $\frac{1}{2}$, that is to say, render it more likely that the event in the second drawing was different from, though not contradictory, to that observed in the first drawing, than that it was not different.

The author then examined the probabilites arising from combined testimony, as expressed by the formula,

$$\frac{1}{1+\left(\frac{1-v}{v}\right)^{n} \cdot \frac{1-p}{p}}=\pi$$

where p is the antecedent probability, v the average veracity of the witness, and n the number of witnesses. The cause of an antecedent probability was stated to be a natural tendency to believe in the continuity of series, and to be, in fact, a modification of the inference from experience.

It was then shewn, that this expression is applicable to the probable correctness of the verdicts of juries, assuming v to represent the probability of correctness in each juryman. Taking the number of the jury at three, it appeared that the probability of getting a correct unanimous verdict, was to the probability of getting a correct verdict by a majority as 3 to 4. But, on the other hand, it appeared that assuming p to be $\frac{9}{10}$, the probability of error in the unanimous verdict is $\frac{1}{6562}$, while the probability of error when two divide against one is $\frac{1}{82}$; that is to say, about eighty times as great as in the former case. Hence it was inferred that verdicts, by a bare majority, are admissible in civil cases, where it is sufficient that the verdict be probably correct; but not in criminal cases, where it is desirable that the probability of correctness should be carried as near to certainty as possible.

Lastly, Whereas there are, in every criminal charge, a certain number of points, all of which the jury desire to know, and which, if all proved, whether for or against the accused, would give a definite probability of his guilt or innocence, but of which one or more may remain untouched by the evidence, it was shewn that the jury would not deal fairly with the case if they threw the non-established point out of view, or if they gave the benefit of the doubt, as it is called, to the prisoner. Supposing $\frac{a}{a+b}$ to be the probability of guilt, independently of the non-established point, which must be considered as equally likely to be really for as against the accused, we must see that the consideration of this adds $\frac{1}{2}$ to a, and the same to b. So that $\frac{a}{a+b}$ becomes $\frac{a+\frac{1}{2}}{a+b+1}$; and these, reduced to a common denominator D, are $\frac{2a^2+2ab+2a}{D}$ and $\frac{2a^2+2ab+a+b}{D}$. So that the considera-

tion of the omitted point increases or diminishes the probability of guilt, according as $a + b$ is greater or less than $2a$, or a greater or less than b: That is to say, the preponderance of the greater probability is diminished by the consideration of each unproved note. If, as was supposed to be generally the case in criminal trials, the probability from the evidence preponderates against the accused, then he does get a benefit from the due consideration of each unproved note, though very far from the benefit he would have gained by proving it in his favour.

2. On the Gradual Production of Luminous Impressions on the Eye, and other phenomena of Vision. By William Swan, F.R.S.E.

The object of this communication was to ascertain the relation between the apparent brightness of a light, and the time during which it acts on the eye. In order to examine the intensity of luminous impressions of short duration, the author made use of discs, having sectors of known angles cut out of their circumferences, which were made to revolve at known velocities between the eye and a luminous object. In this manner, the object is seen at each revolution of the disc for a short interval of time, of which the duration is easily ascertained. An instrument termed a selaometer (from σελας, *brightness*), to indicate its use as a measure of the intensity of luminous impressions, was devised for the purpose of comparing the brightness of the flashes caused by the revolution of the disc, with a light of known intensity. This instrument consists of two screens, placed so as to face each other, having each a circular aperture of the same diameter, to which is fitted a piece of obscured glass. A disc, having a sector of a known angle, revolves in front of one of these screens, so that the aperture in it is visible at each revolution of the disc throughout the sector. The apertures are illuminated by gas flames behind them, which admit of having their distances from the screens varied, so as to increase or diminish the illumination of the apertures. A rectangular prism of glass is placed half way between the apertures, with its faces inclined at angles of 45° to the line joining their centres; so that they are seen in apparent contact by reflexion from the faces of the prism, and their relative brightness

can thus be compared with great nicety. The light behind the revolving disc is kept at a constant distance from the screen during an experiment; and, before causing the disc to revolve, the apertures are made equally bright by varying the distance of the other light from its screen. When the disc is put in motion, the apparent brightness of the aperture behind it is instantly diminished; and the equality of the apparent brightness of the apertures in the screens is restored, by increasing the distance of the light from the other screen. The ratio of the brightness of the impression produced by the light during the revolution of the disc, to the brightness of its impression, when seen by uninterrupted vision, is that of the squares of the distances of the other light from the aperture in its screen.

The following are the principal results obtained by means of this apparatus:—

(1.) When the eye receives, from a light of constant intensity, a succession of flashes of equal duration, which succeed each other so rapidly as to produce a uniform impression, this impression will also have a constant intensity, provided the number of flashes in a given time varies inversely with the duration of each flash.

(2.) The brightness of the impression produced by flashes of light of a given intensity, which succeed each other so rapidly as to produce a uniform impression on the eye, is proportional to the number of flashes in a given time.

(3.) When light of a given intensity acts on the eye for a short space of time, the brightness of the luminous impression on the retina is exactly proportional to the time during which the light continues to act. This law has been proved to be true for impressions lasting from $\frac{1}{18432}$ to $\frac{1}{24}$ of a second. The intensity of the impression produced by light which acts on the eye for $\frac{1}{100}$ of a second, is almost exactly $\frac{1}{10}$ of the brightness of the light when seen by uninterrupted vision; and it is also ascertained that light requires about the tenth part of a second to produce its full effect on the eye.

(4.) It is found that lights of different intensity act on the eye with equal rapidity, so that even the light of the sun produces an impression with no greater rapidity than that of a common gas flame.

(5.) Rays of different refrangibility act on the eye with equal rapidity.

(6.) Since Professor Wheatstone's experiments have proved that

the light of the electric spark of high tension continues for less than the millionth part of a second, and it has been shewn that the brightness of the impression, produced by light on the eye, increases in the exact arithmetical proportion of the time during which it continues to act on the retina, it follows that the apparent brightness of the electric spark is only $\frac{1}{100000}$ of what it would become if the duration of the spark could be prolonged to $\frac{1}{10}$th of a second. From the great apparent brilliancy of the nearly instantaneous electric spark of high tension, when compared with the sensibly continuous light of Voltaic electricity, it is inferred that the brightness of electrical light increases with the tension of the electricity.

3. Note on the Refractive and Dispersive Powers of the Humours of the Eye, determined by Experiment. By John Adie, Esq.

The author's object in undertaking these experiments, was to discover if the achromatism of the eye could be accounted for by the differences in the dispersive ratios of the fluids forming that organ.

The indices for several of the fixed lines were determined in the aqueous humour; with the crystalline no satisfactory result could be obtained.

In subjecting the vitreous humour to experiment, only the strongest of the fixed lines could be seen, and that with great difficulty; one remarkable feature, however, was observed, viz., that on dividing the mass of humours two spectrums were formed, the one placed over the other, having a greater deviation, and, consequently, refractive power. Thus proving, that that humour is not of equal density throughout, as has heretofore been supposed.

The following Donations to the Library were announced:—

The London University Calendar for 1849. 8vo.—*By the University.*

The Ethnological Journal, No. 10. 8vo.—*By the Editor.*

Suite of the Collection of Hydrographic Charts, with Sailing Directions, &c.—*By the Lords Commissioners of the Admiralty.*

Monday, 2d *April* 1849.

General Sir T. MAKDOUGALL BRISBANE, Bart., President, in the Chair.

The following Communication was read :—

1. On Grooved and Striated Rocks in the Middle Region of Scotland. By Charles Maclaren, Esq.

In this paper an account was given of grooved, striated, and abraded rocks in various parts of Scotland, from Glen Spean on the north, to the Pentland and Lammermoor Hills on the south. After indicating the direction in which the groovings pointed, it was shewn,—that the appearance of these grooved and striated rocks is irreconcilable with the hypothesis which ascribes the phenomena to a supposed great Atlantic wave or transient flood, of which one part swept across the low lands of Scotland, while another part was turned back by the mountains,—that in the district between the Clyde and the Spean, where the largest and best marked groovings were observed, there is satisfactory evidence to prove, that they were produced by bodies of vast depth occupying the valleys, moving from the mountain group as a common centre, toward the coast and the Lowlands in all directions, and exerting an immense force of pressure vertically and laterally,—that this quaquaversal motion, as well as the form, position, and size of the groovings, are conclusive against the idea that they were caused by currents of water loaded with stones and gravel, since no collected mass of water exists, or could exist, of the requisite magnitude and elevation, to send out streams in all directions capable of acting powerfully at the height of a thousand feet or more above the bottoms of the valleys,—that the effects mentioned, therefore, can only be accounted for by the agency of glaciers, as exemplified in the Swiss Alps, where glacier ice is found covering immense areas, filling the valleys, and grooving and abrading their sides to the height of one or two thousand feet,—finally, that the striæ, groovings, and abrasion seen in the great central valley of Scotland, and on the Pentland Hills, are probably due to icebergs or rafts of ice, to which also the transportation of many travelled boulders may be ascribed.

The following Donations to the Library were announced :—

Annuaire Météorologique de la France pour 1849. Par MM. J. Haeghens, Ch. Martins, et A. Bérigny. 8vo.—*By the Authors.*

Bulletin des Séances de la Société Vaudoise, No. 19. 8vo.—*By the Society.*

Memorie della R. Accademia delle Scienze di Torino. Serie 2da. Tom. VII,, VIII., IX. 4to.—*By the Acadmy.*

Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar. 1847, No. 10; 1848, Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9. 8vo.

Kongl. Vetenskaps-Akademiens Handlingar för År 1846. 8vo.—med Plaucher. 4to.

Arsberättelse om Zoologiens Framsteg under Åren 1833–44. Tredje Delen, af S. Lovén. 8vo.

Arsberättelse om Zoologieus Framsteg under Åren 1845 och 1846, af C. H. Boheman. 8vo.

Arsberättelse om Framstegen i Kemi och Mineralogi, af Jac. Berzelius. 8vo.—*By the R. Academy of Stockholm.*

Œuvres de Laplace. Tom. V., VI., VII. 4to.—*By the French Government.*

Aanteekeningen, &c. van het Provinciaal Utrechtsch Genootschap van Kunsten en Wetenschappen. 1847 & 1848. 8vo.

Verslag, &c. van het Provinciaal Utrechtsch Genootschap van Kunsten en Wetenschappen. 1847 & 1848, 12°.—*By the Society.*

Report on the Epidemic Cholera at Madras in 1824. By William Scot. 8vo.—*By the Author.*

Monday, April 16, 1849.

Dr CHRISTISON, V.P., in the Chair.

The following communications were read :—

1. On a Simple Form of Rain-Gauge. By the Rev. Dr Fleming.

The author began by stating, that during a calm, when the rain-drop was under the influence of the centripetal force only, the form

and position of the rain-gauge were unimportant. The case, however, was widely different when the drop was likewise influenced by wind, for then any object raised above the surface, such as a rain-gauge projecting three or four feet from the ground, occasioned deflections and eddies, whereby the regular fall of the rain into the collector was prevented. The Author then recommended, that in all cases the gauge should be placed on the ground, with its mouth on a level with a regularly trimmed grass plot, so as to prevent eddies and evaporation. The form which he considered unexceptionable (an example executed by Mr James Bryson, 66 Princes Street, being exhibited) was that of a copper cylinder, with a funnel-form partition placed about an inch and a half below the mouth, having an aperture for the index of a float, which rises as the rain passes into the receiving portion of the lower part of the cylinder, at the bottom of which is a stopcock for letting off, at times, the accumulated water. A second cylinder of copper, closed at bottom, is provided, to be inserted into the ground for the reception of the gauge, the latter having a shoulder or flange to prevent the entrance of earth. By this arrangement the collector and receiver are equal in area, so that errors of workmanship are avoided. The state of the gauge is known by simple inspection of the index of the float, and extreme facility of emptying and adjusting the instrument secured.

2. On a Method of Cooling the Atmosphere of Rooms in a Tropical Climate. By Professor C. Piazzi Smyth.

After stating the case distinctly, and dwelling emphatically on its importance, as shewn by individual instances in private life, and by the statistics of the world at large, the author proceeded to describe the various methods adopted at present in India, and shewed their incapacity to meet the end proposed, as they merely agitated the air already in a room, or perniciously overloaded it with moisture.

To take the most difficult case that could occur, he chose that of a country where the mean temperature of day and night, and summer and winter, is never below 80°, and where there could, consequently, be no coolness in springs or rivers, or in the night air; where also the atmosphere being saturated with moisture, no cold could be produced by evaporation; and under such circumstances

proposed that a method should be found of lowering the temperature of the air in a room; doing, in fact, there, the reverse of what is effected in a cold room by lighting a fire.

The principle of the plan which he brought forward was dependent on the property of air to increase in temperature on compression, and to diminish on expansion; the air was to be compressed by a forcing pump into a close vessel, then cooled or rather deprived merely of its acquired heat of compression, and then being allowed to escape into the room desired to be cooled, would issue at a temperature as much below that of the atmosphere as it had risen above on compression.

That this was a *vera causa* there was no doubt; the *sufficiency* and the *practicability* were the only matters of doubt. These the author attempted to solve, by shewing the quantity of increase of heat due to a certain amount of compression; and by devising the most convenient form of the necessary apparatus, and concluded that a one-horse power should supply a room with 30 cubic feet of air per minute, cooled 20° below the surrounding atmosphere. The various sources of mechanical power likely to be met with in warm countries, were then described; and particularly a new and simple, and at the same time, a remarkably compact and effective form of windmill; as the wind is everywhere so cheap and abundant, and in the tropics so certain a species of moving power. Methods also of ventilating the cooled room, *i. e.*, of keeping it constantly supplied with cooled fresh air, and removing the vitiated, were explained, as well as a natural principle for meeting the residual difficulty that might be expected to arise in some cases, viz., the too great moisture of the cooled air.

3. Notice of a Shooting-Star. By Professor C. Piazzi Smyth.

The object of this notice was merely to call attention to the importance of observing the phenomena of shooting-stars more carefully and rigidly, and of applying to them more correctly than has generally been the case hitherto, the measurement of time and of space, and to exemplify what may be done in this way by the calculation of a recent instance. This instance, the rare one of an *ascending* shooting-star, was furnished by Captain W. S. Jacob, Bombay Engineers; and he having given the place where the body first appeared, that

where it disappeared, and the time, the author of the paper, who had great faith in his friend's exactitude, considered the opportunity favourable for trying what results would be given by the application of Sir J. Lubbock's theory.

Some dissatisfaction has been felt about theories of shooting-stars, inasmuch as no one of them will explain *all* the observed phenomena. But though this is undoubtedly a necessary characteristic of a true theory, still great allowances are necessary here where so many different classes of cosmical and atmospherical objects may be confounded even by practised observers; and where the greater number of observers are utterly unpractised, and their senses wholly uneducated for scientific observation. Allowing that some electrical and magnetical effects have been mistaken for shooting-stars, but excluding the baseless electrical, chemical, and lunar hypotheses, a great proportion are undoubtedly of a cosmical nature, and belong properly to astronomy; and these may be divided into two classes of small bodies. 1*st*, Those which are circulating round the sun as a primary; and 2*dly*, Those which are revolving round the earth as such. The first we may occasionally see when passing near them in their orbits, but are not likely to come within sight of the same again, unless, indeed, they approach so near the earth as to gravitate towards it instead of the sun, and so become satellites or shooting-stars of the second class.

Sir J. Lubbock's theory is, that the shooting-stars shine by reflected light, and are extinguished by entering the earth's shadow; and he has given formulæ on this supposition for computing the distance of the body from the spectator by noting the place in the sky where, and the time when, the extinction occurs.

These formulæ have been rendered more convenient for computation by Mr Archibald Smith, *Phil. Mag.*, March 1849; and, computed according to them, Captain Jacob's observation gives, for the distance of the body from the observer, 1721 miles; and that entry into the earth's shadow was the true cause of the disappearance, is borne out by the fact that the direction of motion was *towards* the axis of the earth's shadow. And, on account of the extremely small distance of the body, its change of place during flight would sufficiently account for its gradually appearing in the lower part of the sky when coming out of conjunction, increasing in brilliancy during its flight (reaching, at its maximum, the brightness of Venus), and

then slowly vanishing as it entered first the penumbra and then the umbra of the earth's shadow, in a slanting direction ; and lastly, the body can hardly fail of being a satellite, as its distance is so much less than that of a shooting-star, which M. Petit of Toulouse has pretty well identified as revolving about the earth in 3^h 20^m, or at about 3000 miles from the surface.

4. A few unpublished particulars concerning the late Dr Black. By Dr George Wilson.

The object of this communication was to lay before the Society a few characteristic incidents concerning Dr Black, gathered from Mrs Elizabeth Wordsworth, who was a servant in his household during the five last years of his life.

The facts recorded do not admit of abridgment, but they completely confirmed the accounts contained in the published biographies of Black, concerning his valetudinarian and methodical habits, whilst they gave no countenance to the statement which had been credited in some quarters, that the great chemist was an avaricious or penurious man. Some interesting particulars were adduced illustrative of the amiability and gentleness which characterised Dr Black; and the author concluded by noticing that an error had been committed as to the date of the philosopher's death, which was not the 26th of November 1799, as stated by Robison, but the 6th December of that year, a fact which Mr Muirhead first pointed out (*Watt's Correspondence*, p. xxii.), but which is confirmed by the newspapers of the period. (*Vide Edinburgh Mercury* of 14th December 1799.)

Dr Christison then exhibited some interesting Specimens of Alum-Slate, illustrative of the Manufacture of Alum, and described both the natural and artificial processes.

The following Donations to the Library were announced :—

Journal of the Asiatic Society of Bengal. Edited by the Secretaries. Nos. 196 and 197. 8vo.—*By the Editors.*

Proceedings of the Royal Astronomical Society. Vol. IX., No. 5. 8vo.—*By the Society.*

Monday, April 30, 1849.

Bishop TERROT, V.P., in the Chair.

The following communications were read:—

1. On a New Voltaic Battery of Intense Power. By Dr Wright. Communicated by Dr George Wilson.

The author placed on the table a battery of four pairs, each consisting of a rod of coke $2\frac{1}{2}$ inches long by $1\frac{1}{2}$ in diameter, surrounded by a cylinder of amalgamated zinc, $2\frac{1}{2}$ inches high by $2\frac{1}{4}$ inches in diameter; the different pairs were firmly attached to the same bar of wood, and could be immersed in jars of stoneware at once. The arrangement was charged with a mixture of nitric acid one part, sulphuric acid four parts, water eight parts. The author stated that he considered the power of the battery, which was twice that of Grove's, was due to the heat generated on the surface of the zinc by the local action of the nitric acid.

2. On a New Species of Manna, from New South Wales. By Thomas Anderson, M.D.

About thirty years ago a species of manna, obtained from the Eucalyptus Mannifera, was brought from New South Wales, and was examined by Dr Thomas Thomson, and afterwards by Professor Johnston, both of whom ascertained it to contain a new species of sugar, different from the mannite which exists in ordinary manna. The author had, through the kindness of Mr Sheriff Cay, an opportunity of examining a very different species of manna, remarkable both from its chemical constitution, and from its possessing a definitely organised structure. This substance was discovered by Mr Robert Cay in 1844, in the interior of Australia Felix, to the north and north-west of Melbourne, where it occurs at certain seasons on the leaves of the Mallee plant, Eucalyptus Dumosa, and is known to the natives by the name of Lerp.

It consists of numerous small conical cups of the average diameter of a sixth of an inch, more or less distinctly striated, and covered

on the outside with hairs of considerable length. The cup resembles some of the smaller species of patella, and its mouth is perfectly smooth and round. Several of the cups are frequently attached to one another by the edges, and always so that their mouths form a plane, by which it would appear they have been attached to the leaves. The hairs, when examined under the microscope, were found to consist of uniform tubes, with a granular structure, and indistinct traces of transverse striæ; they are coloured uniformly blue by iodine. The cups are made up of a confused mass of closely-compacted cells resembling starch globules, and coloured blue by iodine.

The taste of Lerp is distinctly saccharine, but this is confined entirely to the hair, the cup having merely a mucilaginous taste. The chemical examination shewed it to consist of an uncrystallisable sugar similar in its character to that found in fruits, of starch, gum, inulin, and cellulose, the absolute identity of the latter two of which was determined by ultimate analysis. There were also found minute traces of resinous matter and nitrogen, and 1·13 per cent of ash. The following is the result of its quantitative analysis :—

Water,	15·04
Sugar with a little resinous matter,	49·06
Gum,	5·77
Starch,	4·29
Inulin,	13·80
Cellulosa,	12·04
	100·00
Ash,	1·13

The author, in concluding his paper, remarked that all the species of manna before observed consisted of soluble substances, and were considered to be produced by the puncture of an insect, which caused the exudation of their constituents in the fluid form, and that they gradually dried up upon the surface of the leaf, but that the existence in Lerp of the insoluble cellulose and starch, and the sparingly-soluble inulin, seemed scarcely compatible with such an explanation of its origin.

3. Account of a peculiar Structure found in the Vagmarus Islandicus. By Dr John Reid. Communicated by Professor Goodsir.

4. Notes to a Paper on the Motive Power of Heat. By Professor William Thomson.

(1.) *On the Values of μ derived from Observations on the Vapours of various Liquids.*

An important test of the truth of the axiom on which Carnot's Theory is founded, will be afforded by comparing the values of μ deduced from observations on various liquids. I am informed by Mons. Regnault, that, by the end of this year, data as complete as those which we at present possess for water, will be supplied for five or six different liquids, from certain investigations with which he is now occupied. Carnot gives values of μ for the temperatures of the boiling of sulphuric ether, alcohol, water, and essence of turpentine, derived from various observations upon those liquids. The comparison of these with the values of μ, deduced from Regnault's continuous series of observations on water, are exhibited in the following table:—

Names of the Liquids.	Boiling-points.	Carnot's deduced values of μ.	Values of μ deduced from Regnault's Experiments on Water.	Differences.
		Ft. lbs.	Ft. lbs.	
Sulphuric Ether,	35·5	4·48	4·51	·03
Alcohol, . .	78·8	3·96	4·03	·07
Water, . .	100	3·66	3·84	·18
Essence of Turpentine, .	156·8	3·53	3·45	−·08

The coincidences of the results obtained by such very different experiments are very striking. The differences certainly lie within the limits of the errors of observation; for it happens that the difference of the two results deduced by the different experimenters, from water at the boiling-point, is greater than any of the other differences. It is very remarkable that the feature of the gradual

decrease of μ with the temperature should be so clearly brought out by observations performed on different liquids, at different temperatures.

(2.) *On the Heat developed by the Compression of Air.*

Carnot demonstrates the following proposition :—

Equal volumes of all elastic fluids, when compressed to equal smaller volumes, disengage equal quantities of heat.

This very remarkable proposition, given as a theorem by Carnot, was enunciated as a probable experimental law by Dulong; and it therefore affords a very powerful confirmation of Carnot's fundamental principle.

Mr Joule of Manchester has made some important experiments on this subject. The view which he takes of a thermal "equivalent" for motive power is at variance with Carnot's theory, but his experimental results agree with its indications in a very satisfactory manner. In endeavouring to effect a comparison, I found that the following propositions are a consequence of Carnot's Theory.

1. *In compressing a gas of which the temperature is kept invariable, the amount of work spent is exactly proportional to the quantity of heat developed.*

2. *The amount of work necessary to produce a unit of heat in this manner is the same, whatever be the gas operated on, but depends upon the temperature, being determined by the expression*

$$\frac{\mu(1+Et)}{E}.$$

(3.) *On the Specific Heats of Gases.*

Carnot proves, as a theorem, that *the excess of the specific heat* under a constant pressure above the specific heat at a constant volume is the same for all gases at the same temperature and pressure.*

This result agrees well with the experimental results obtained by Dulong.

Carnot's theory affords the following determinate expression for the difference alluded to in the enunciation :

$$\frac{E^2 p}{\mu(1+Et)^2}$$

* *i.e.* The "capacity for heat" of a unit of volume.

(4.) *Comparison of the Relative Advantages of the Steam-Engine and Air-Engine.*

In the steam-engine, with the expansive principle pushed to the utmost, as Carnot points out, the *effective range of temperature*, or the *fall* utilised, is from the temperature of the boiler to that of the condenser. The superior limit of temperature is restricted by the circumstance, that the pressure of saturated steam is enormously great for high temperatures; so that in practice, the temperature in the boiler is not in any ordinary engines so high as 150° per cent., but is in general very much below this limit. Carnot points out, that in this respect, the air-engine has a vast advantage over the steam-engine; as there is no limit to the temperature in the hot part, except such as the preservation of the materials requires; and, therefore, in it an enormously greater portion of the whole fall, from the temperature of the coals to that of the atmosphere, may be made use of. In other respects, we have no reason *a priori* for giving a preference to one kind of engine above the other. We cannot, however, feel confident that any air-engine has yet been constructed, which is capable of economising the fall actually used, as well as is done by steam-engines, with their comparatively limited range of temperature, or even that the duty for fuel consumed has in any actual air-engine exceeded or even come up to the duty performed by the best steam-engines.

(5.) *On the Economy of Actual Steam-Engines.*

The following table affords a synoptic view of the performances and theoretical duties, in various actual cases.*

When heat is transmitted from a body at 140°,† through an engine, to a body at 30°, the work due to each unit of heat is 439 foot-pounds. This is the "theoretical duty" referred to in the last column in the table.

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* I am indebted to the kindness of Professor Gordon, of Glasgow, for the experimental data.

† Pressure $3\frac{1}{2}$ atmospheres; 37 lb. on the square inch of the safety-valve.

Table A.—*Various Engines in which the Boiler is at 140°, and the Condenser at 30°.*

Cases.	Work produced for each lb. of coal consumed.	Work produced for each lb. of water evaporated.	Work produced for each unit of heat transmitted.	Per-centage of theoretical duty.
	Ft.-lbs.	Ft.-lbs.	Ft.-lbs.	
(1.) Fowey Consols Experiment, reported in 1845,	1,488,000	175,000	283	$64\frac{1}{2}$
(2.) Taylor's Engine at the United Mines, working in 1840,	1,167,000	137,300	222	$50\frac{1}{2}$
(3.) French Engines, according to contract,	* * * *	98,427	159	36
(4.) English Engines according to contract,	565,700	66,550	108	$24\frac{1}{2}$
(5.) Average actual performance of Cornish Engines,	631,000	74,240	120	$27\frac{1}{3}$
(6.) Common Engines, consuming 12 lb. of coal per hour, per horse-power.	165,000	19,410	31·4	$7\frac{1}{8}$
(7.) Improved Engines, with expansion cylinders; using an equivalent to 4 lb. of best coal per horse-power, per hour.	495,000	58,240	94·3	$21\frac{1}{2}$

5. Note regarding an Experiment suggested by Professor Robison. By Professor J. D. Forbes.

In his memoir of Dr Chalmers, lately read to this Society, Mr Ramsay has referred to an experiment which Dr Chalmers was anxious to have performed on the tide-wave in the Bay of Fundy. The object was to determine the earth's density by the attraction of the tide-wave on a plummet or spirit-level, on the same principle as

Maskelyne's experiment on Schiehallion, but with the superior advantages arising from the perfect homogeneity of the attracting mass, and from the circumstance that all the observations might be made at a single station. The experiment might, in short, appear to unite the advantages both of Maskelyne's and Cavendish's methods of determining the earth's density.

The suggestion was Dr Robison's, and Dr Chalmers had it from him. It is contained in the *Elements of Mechanical Philosophy*, Edit. 1804, page 339, and is given in the following words:—"Perhaps a very sensible effect might be observed at Annapolis-Royal in Nova Scotia, from the vast addition of matter brought on the coast twice every day by the tides. The water rises there above 100 feet at spring tide. If a leaden pipe a few hundred feet long were laid on the level beach, at right angles with the coast, and a glass pipe set upright at each end, and the whole filled with water, the water will rise at the outer end, and sink at the end next the land as the tide rises. Such an alternate change of level would give the most satisfactory evidence. Perhaps the effect might be sensible on a very long plummet, or even a nice spirit-level."

It is needless to observe that the methods proposed by Dr Robison are not the best which might be suggested; but that, in consequence of the extreme simplicity of the observation, considered as a purely astronomical one, a deviation of the direction of gravity of only a very few seconds could be ascertained within small limits of error.*

I thought it worth while to make the calculation approximately for an assumed height of the tide-wave. Had the result been at all encouraging I should have taken pains to ascertain, on good authority, the exact rise of the tide, and the circumstances of the locality whence the rise is greatest.

I have calculated the horizontal attraction of a semicylinder of water 100 feet thick, and of about two, four, and eight miles radius upon a point at the extremity of the axis of such a semicylinder; because these conditions can easily be reduced to calculation, and because

* The micrometric observation of a plumb-line, as in a zenith sector, would be sufficient; or, as Professor Smyth has suggested to me, the view of the wires of a transit instrument, with a collimating eye-piece, as reflected in a mercury trough,—an observation, the accuracy of which may, he states, be brought within $\frac{1}{20}$ of a second.

they represent very approximately the circumstances of an attracted point placed at high water-mark on a vertical sea-wall facing a basin or estuary. The radius of the attracting mass of water being represented (more accurately) by 10,000, 20,000, and 40,000 feet, I find the influence of a tide-wave 100 feet thick upon a plumb-line to produce a deviation of only 0·″44 (forty-four hundredths of a second), 0·″50, and 0·″53; the effect increasing extremely slowly with the radius, as might be expected. If the tide rose only fifty feet, the first effect would be reduced to 0·″246.

Even the greatest of these calculated deviations affords no ground for hoping that the method of Robison could be applied with any success to determine the earth's density.

It is rather singular that this ingenious suggestion is not once alluded to, so far as I am aware, by any writer on the figure and density of the earth; yet surely it was as worthy of notice as Dr Hutton's proposal to measure the attraction of an Egyptian pyramid.—(*Phil. Trans.* 1821.)

The following Donations to the Library were announced:—

American Journal of Science and Arts. Conducted by Professors Silliman and Dana. 2[d] Ser. Vol. VII., No. 20. 8vo.—*By the Editors.*

Ethnological Journal. No. 11. 8vo.—*By the Editor.*

Passages in the History of Geology. By Andrew C. Ramsay, F.G.S. 8vo. (2 copies.)—*By the Author.*

On the Nature of Limbs. By Richard Owen, F.R.S. 8vo.—*By the Author.*

Proceedings of the Philosophical Society of Glasgow. Vol. II. 1844–8. 8vo.—*By the Society.*

The Philosophy of Trade; or Outlines of a Theory of Profits and Prices. By Patrick James Stirling. 8vo.—*By the Author.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. II. 1849–50. No. 35.

SIXTY-EIGHTH SESSION.

Monday, 3d December 1849.

Hon. Lord MURRAY, V.P., in the Chair.

The following Communication was read:—

1. Personal Observations on Terraces, and other proofs of Changes in the relative Level of Sea and Land in Scandinavia. By Robert Chambers, Esq., F.R.S.E., &c.

In this paper were given descriptions of alluvial formations of a terassiform character in the valley of the Lir river, near Drammen, in Norway, and of similar objects in valleys near the foot of the Miösen lake. The author then described a remarkable terrace which runs for fully fourteen miles at one elevation along the upper part of the valley of the Logan, in the Dovre field. It is composed on the left side of the valley of water-laid sand, and is believed to be about 2150 feet above the level of the sea. On the Dovre field, several hundred feet higher, are morasses containing the remains of much greater trees than are now growing in that district, the highest vegetation of which is a dwarf birch; and Mr Chambers remarks, that when the terrace was on the sea-level this district would enjoy a temperature fit for the production of such large timber. Mr Chambers next described some remarkable terraces in the valleys near Trondhiem, and particularly the great terrace of erosion which overlooks that city at an elevation of 522 feet above the sea.

The remainder of the paper was chiefly devoted to an account of a remarkable couple of terraces, which are traceable along the coasts of Nordlands and Finmark, apparently at one level (57 and 143 feet above the sea), excepting in the sounds near Hammerfest; where, throughout a space of twenty-five miles, they are upon an

inclination. This portion of the phenomena fell under the attention of M. Bravais, of the French Scientific Expedition of the North, by whom they were measured barometrically and described. The present observer took measurements of these inclined terraces by the level and staff, in eighteen or twenty places, and thus confirmed the views of his predecessor. By Mr Chambers's observations, the following new points are ascertained: 1. The terraces, as being inclined, form an exceptive case, in contrast with those of a neighbouring district of coast of much larger extent (at least 180 geographical miles). 2. The disturbed district has moved on an axis of rest near Nœverfiord, where the two terraces are about the normal height. 3. A line, 14° west of north, (being nearly the line of the magnetic meridian), being drawn across the disturbed district, the inclination is shewn to be equable throughout equal spaces of that line, which is thus proved to be the meridian of the movement. 4. The northern extremity of the dip of the upper line at Hammerfest is 58 feet below, and the southern extremity, abreast of the Alten terraces, is 96 feet above the axis of rest.

The author then described visits which he paid in September 1849 to two of the places in the Gulf of Bothnia where marks have been made in order to detect the rate of movement of the land; at the rock near Löfsgrund he found the sea about six inches below the mark made sixteen years before by Sir Charles Lyell; while, on the cliffs of Grasöe, where Flumen made a mark in 1820, the water was exactly eleven inches lower.

His Grace the Duke of Argyll

was duly elected an Ordinary Fellow.

The following Donations to the Library were announced:—

Address delivered at the Anniversary Meeting of the Geological Society of London, 16th February 1849. By Sir H. de la Bêche. 8vo.—*By the Author.*

Proceedings of the American Philosophical Society. Vol. V., No. 41. 8vo.—*By the Society.*

Journal of the Statistical Society of London. Vol. XII., Pt. 2. 8vo. —*By the Society.*

Scheikundige Onderzoekingen, gedaan in het Laboratorium der Utrechtsche Hoogeschool. 5de Deel, 1ste, 3de, & 4de Stuk. 8vo.—*By the University.*

The American Journal of Science and Arts. Vol. VII., No. 21. 8vo. Edited by Professors Silliman and Dana.—*By the Editors.*

Journal of the Asiatic Society of Bengal. Edited by the Secretaries. New Series, No. 25. 8vo.—*By the Editors.*

Quarterly Journal of the Geological Society of London. No. 16. 8vo.—*By the Society.*

Bulletin de la Société Géologique de France. Tom. XIV., & Tom. I. & II. 2de Série. 8vo.—*By the Society.*

Sixteenth Annual Report of the Royal Cornwall Polytechnic Society, 1848. 8vo.—*By the Society.*

The Journal of Agriculture and Transactions of the Highland and Agricultural Society of Scotland. No. 25, N.S., July 1849. 8vo.—*By the Publishers.*

The Journal of the Royal Geographical Society of London. Vol. XIX., Part 1, 1849. 8vo.—*By the Society.*

Verhandelingen der Eerste Klasse van het K. Nederlandsche Instituut van Wetenschappen, Letterkunde, en Schoone Kunsten te Amsterdam. 3de Reeks, 1sten Deels, 2de Stuk. 4to.

Tijdschrift voor Wis-en Natuurkundige Wetenschappen, uitgegeven door de Eerste Klasse van het K. Nederlandsche Instituut van Wetenschappen, Letterkunde en Schoone Kunsten. 2de Deel, 3e & 4e Afleverings. 8vo.—*By the Institute.*

Report of the Eighteenth Meeting of the British Association for the Advancement of Science, held at Swansea, in August 1848. 8vo.—*By the Association.*

Neue Denkschriften der Allgemeine Schweizerischen Gesellschaft für die gesamten Naturwissenschaften. Bde. 8 & 9. 4to.

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft bei ihrer Versammlung zu Winterthur 1846 & 1847. 8vo.

Mittheilungen der Naturforschenden Gesellschaft in Bern. Nos. 87–134. 8vo.

Die Wichtigsten Momente aus der Geschichte der drei ersten Jahrzende der Schweizerischen Naturforschenden Gesellschaft. 1848. 8vo.—*By the Society.*

Antiquités Celtiques et Antidiluviennes. Mémoire sur l'Industrie primitive et les arts à leur origine. Par M. Boucher de Perthes. 8vo.—*By the Author.*

Meteorologische Beobachtungen angestellt auf Veranstaltung der Naturforschenden Gesellschaft in Zürich. 1837–46. 4to.

Denkschrift zur Feier des hundertjahrigen Stiftung festes der Naturforschenden Gesellschaft in Zürich am 30 November 1846. 4to.—*By the Society.*

Mittheilungen der Naturforschenden Gesellschaft in Zürich. Heft I., (No. 1–13). 8vo.—*By the Society.*

Proceedings of the American Philosophical Society. Vol. V., January, March, 1849. No. 42. 8vo.—*By the Society.*

The Progress of the development of the Law of Storms, and of the Variable Winds, with the practical application of the subject to Navigation. By Lieut.-Colonel William Reid. 8vo.—*By the Author.*

On the Geological Structure of the Alps, Apennines, and Carpathians, more especially to prove a transition from Secondary to Tertiary Rocks, and the development of Eocene Deposits in Southern Europe. By Sir Roderick Impey Murchison. 8vo.—*By the Author.*

Account of the effect of a Storm on Sea-Walls or Bulwarks on the coast near Edinburgh, as illustrating the principle of the construction of Sea-Defences. By W. M. Rankine. 8vo.

An Equation between the Temperature and the maximum elasticity of Steam and other vapours. By W. M. Rankine. 8vo.—*By the Author.*

The American Journal of Science and Arts. Conducted by Professors Silliman and Dana. 2d Series, No. 22, July 1849. 8vo.—*By the Editors.*

Journal of the Asiatic Society of Bengal. Edited by the Secretaries. No. 200, February 1849. 8vo, and N.S., No. 28, April 1849, and No. 203.—*By the Editors.*

Journal of the Statistical Society of London. Vol. XII., Parts 3 and 4. 8vo.—*By the Society.*

Journal of the Geological Society of Dublin. Vol. IV., Part 1. 8vo.—*By the Society.*

Catalogue of the Calcutta Public Library. 8vo.—*By the Council.*

Flora Batava. 159 Aflevering. 4to.—*By the King of Holland.*

A Letter addressed to the Earl of Rosse, President-Elect of the Royal Society. By Marshall Hall, M.D. 8vo.

On the Neck as a Medical Region, and on Trachelismus ; on Hidden Seizures ; on Paroxysmal Apoplexy, Paralysis, Mania, Syncope, &c. By Marshall Hall, M.D. 8vo.—*By the Author.*

Astronomical Observations made at the Radcliffe Observatory. By Manuel J. Johnson. 1842, 1843, 1844, 1845, 1846, 1847. Vol. III.—VIII. 8vo.—*By the Radcliffe Trustees.*

Quarterly Journal of the Geological Society. No. 18, 1849. 8vo. —*By the Society.*

Journal of the Indian Archipelago and Eastern Asia. Vol. III. Nos. 1, 2, 3, 4. 8vo.—*By the Editor.*

The American Journal of Science and Arts. Conducted by Professors Silliman and Dana. Second Series. No. 23. 8vo.—*By the Editors.*

Memoirs of the Ganglia and Nerves of the Uterus. By Robert Lee, M.D. 4to.

On the Ganglia and Nerves of the Heart. By Robert Lee, M.D. 4to.—*By the Author.*

Athenæum. Rules and Regulations, List of Members, &c. 1847. 12mo.

——— Annual Report—General Abstract of Accounts. 1848.—*By the Athenæum.*

Description of a Machine for Polishing Specula, with Directions for its use. By W. Lassell, Esq. 4to.—*By the Author.*

Monday, 17th December 1849.

Right Rev. Bishop TERROT, V.P., in the Chair.

The following Communications were read :—

1. Note respecting the Dimensions and Refracting Power of the Eye.* By Professor J. D. Forbes.

“ Whilst lecturing lately on the subject of Vision, I consulted some recent authorities on the dimensions and curvatures of the refracting apparatus of the eye; and having calculated from them the con-

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vergence of rays within the eye, it may save trouble to others to put them on record.

"The measures of the eye given in almost every English work on the subject, are those given by Young on his own authority, or that of Petit. In the fifth volume of Dove's Repertorium, I find a series of measures collected by Treviranus from his own and preceding observations, which I have converted below from French lines into decimals of an English inch. In these the curvatures are supposed spherical. In the same work of Dove, I find a series of measures by Dr Krause of Hanover, on eight recent human eyes, which seem to have been made with uncommon care, and in which the deviation of the surfaces from sphericity is noticed. I have preferred these last for the purpose of calculation, because *all* the measures are taken from the same eye, which is not the case with the numbers collected by Treviranus. I have consulted the original paper of Krause in Poggendorff's Annalen, vols. xxxi. and xxxix., where it appears, (1.) That the cornea is thicker at the sides than in the centre; (2.) The anterior curve of the cornea is nearly spherical, the posterior parabolic; (3.) The anterior surface of the lens is elliptical, the lesser diameter being in the axis of vision, the posterior surface is parabolic; (4.) The figure of the retina, or the posterior surface of the vitreous humour, is an ellipsoid.

"The following are those given by two eminent German authorities, Treviranus and Krause, when reduced to English inches:—

	Mean of several Authors by Treviranus.	Mean of eight measures by Krause.
	Inches.	Inches.
Thickness of cornea (central part), .	0·032	0·040
Distance of first surface of lens from back surface of cornea, . . .	0·104	0·107
Pupil behind cornea, . . .	0·096	0·083
Thickness of lens, . . .	0·181	0·181
Axis of vitreous humour, . .	0·548	0·567
Axis of the eye from interior of the cornea to the retina, ...	0.833	0·855
Radius of first surface of cornea, .	0·301	0·348
Radius of first surface of lens, . .	0·280	0·369
——— of second do., . . .	0·196	0·201
Curvature of retina near the axis, .	0·534	0·523

These numbers agree tolerably well, only that the radius of cur-

vature of the first surface of the lens is disproportionately great in the last column. This arises from the circumstance, that it is derived by calculation, for the curvature of an ellipse at the lesser axis, the two axes of which are alone given by Krause. Now, it is evident, that if we regard the lens *as a whole*, or even any considerable breadth of it, its mean radius of curvature will be sensibly smaller. In fact, Krause finds that it may be tolerably represented by a circular curvature, having a radius of ·329 inches. It occurred to me, however, that by taking the *greatest* density of the lens, as given by Brewster, and the curvature of the middle part, both anterior and posterior, as given by Krause, I ought to arrive at a close approximation to the course of the axial pencil.

"I have adopted for the refractive indices of the parts of the eye, those given by Sir D. Brewster in his original paper in the Edinburgh Philosophical Journal, vol. i., page 44, with the exception of that of the densest part of the lens, which is almost certainly misprinted. They are as follow :—

Aqueous humour, . . .	1·3366 $= \mu_1$
Crystalline, outer coats, . .	1·3767
———— middle coats, . .	1·3786
———— central coats, . .	1·3990* $= \mu_2$
———— the whole, . .	1·3839
Vitreous humour, . . .	1·3394 $= \mu_3$

"Calculating from the preceding data, with Sir D. Brewster's indices of refraction, the author finds the positions of the foci, towards which the rays converge, after refraction at the successive surfaces, to be the following (reckoning from the *interior* surface of the cornea, the thickness of which has been neglected)—

	For rays falling parallel on the cornea.	For rays diverging from a point 10 inches distant.
	Inches.	Inches.
After first refraction at the aqueous humour, . . .	= 1·382	1·541
After second refraction at first surface of the lens, . .	= 1·260	1·377
After third refraction into vitreous humour, . . .	= 1·060	1·135

* In the Edinburgh Phil. Journ., we find 1·3999. But I take this to be a misprint, as in Sir D. Brewster's own subsequent writings, we always find 1·3990.

"Now the measure of the axis of the eye we have seen to be only ·833 inch, according to Treviranus, and ·855 according to Krause; consequently, rays of mean refrangibility (to which Brewster's measures refer) converge to a point no less than ·227 inch behind the retina, when the rays fall parallel on the cornea, and ·302 when the object viewed is at 10 inches' distance. The axis of the eye, as even measured by Dr Young, though somewhat greater than we have reckoned it above, (Dr Young makes it ·91), does not come up to the requisite dimensions; and Dr Young, with his usual acuteness, ascribes the difference to the gradually varying density of the strata or coats of the lens,* the dense small nucleus evidently acting as a lens of comparatively short focus; and this explanation is probably the correct one, to which we may add, that the configuration of the coats of equal density, which, near the surface of the lens, are very elliptical, become, near its centre, gradually nearly spherical. On this account, it is all but impossible to predict the exact course of the rays through a structure of so much complication.

"Dr Young had considered the case with his usual attention and penetration. He investigates the focus of a spherical lens, or lens with surfaces which are segments of spheres, and whose density is variable, and the result may be recalled here as one which, perhaps, has not been sufficiently remarked. "On the whole," he says, "it is probable that the refractive power of the human crystalline in its living state is to that of water nearly as 18 to 17 [gives index refr. = 1·415]; that the water imbibed after death from the humour of the capsule reduces it to the ratio of 21 to 20 [1·403], but that, on account of the unequable density of the lens, its effect on the eye is equivalent to a refraction of 14 to 13 [1·439] for its whole size."†

"On the whole, these calculations, as well as the considerations into which I entered in a former paper, read to the Society in 1844,‡ on the mechanism of the focal adjustment, have left on my mind the conviction that the optical and mechanical structure of the organ of sight is even less understood than it is commonly believed to be. Simple as are its general arrangements, and comparable, in some respects, to those of artificial combinations, we perceive surfaces figured in a complex manner, and structures of varying refractive

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* Nat. Phil., vol. ii., p. 580. † Nat. Phil., vol. ii., p. 82.

‡ Transactions Royal Society of Edinburgh, vol. xvi., p. 1.

density combined in a very complicated manner. Krause's measures of the curvature of the surfaces of the lens confirm the inadmissibility of the all but universal opinion of the variation of density of the crystalline being intended to correct the aberration of spherical surfaces, when, in reality, no such surfaces exist. We are quite unable to trace the exact course by which the rays of light are focalised on the retina, since it depends on the internal constitution of the lens that they do not meet very far behind it; and it still remains at least doubtful how the adjustment to distinct vision of objects at different distances is effected.

"Finally, the question of achromatism of the eye has its own difficulties. It is not now contended that the eye has the power of converging equally rays of different refrangibilities; but it is not unreasonable to suppose that the chromatic aberration is at least partially corrected. One result of the calculations into which I have entered (which were first in part undertaken at my request, by Mr James Clerk Maxwell, and since entirely repeated and extended by myself), is a clear exhibition of the physical conditions of perfect achromatism in the eye. The form is simpler than I have elsewhere seen, and may at once satisfy any reasonable person of the possibility that the eye might be rendered achromatic, at least for objects at a certain distance; to prove which, so much has been written, and at so great length. The result may be stated in two lines. If we calculate the effect upon the *final* focal distance of the whole refracting system of the eye (q''), of a variation in the refractive index of each of its three humours (denoted by μ_2, μ_3, μ_4). We find this equation when the incident rays are parallel, or reach the eye from a very distant object:—

$$\delta q'' = 1\cdot579\ \delta\mu_2 + 1\cdot150\ \delta\mu_3 - 2\cdot788\ \delta\mu_4.$$

Let the coefficients $\delta\mu_2$, $\delta\mu_3$, $\delta\mu_4$ denote the dispersion or differences of the indices of refraction for extreme rays, corresponding to the three media, then it is evident, from the negative sign of the third term on the right hand, that they may be so chosen as to annihilate the second side of the equation, or make the variation of focal distances *nothing*, for the differently refrangible rays.

"If the rays proceed from a point 10 inches distant from the eye, the equation for the variation of the focus will be

$$\delta q'' = 1\cdot873\ \delta\mu_2 + 1\cdot402\ \delta\mu_3 - 3\cdot298\ \delta\mu_4$$

and the condition which makes this equal to zero, or the focus independent of small variation of the refrangibility of the ray may be satisfied, at the same time that the former equation is satisfied also; consequently, *with three media, as in the eye, we may have perfect achromatism for any two distances;* which would also be sensibly perfect for the intervening ones. Of course by perfect achromatism, we here mean a union of the extreme red and violet rays; the *irrationality* of dispersion does not concern this question."

2. On the Intensity of Heat reflected from Glass. By Professor J. D. Forbes.

The author, after referring to a communication made to this Society, on the 18th March 1839, on this subject, and noticed in the "Proceedings" of that date, stated, that being about to recommence his observations on radiant heat, so long and unavoidably interrupted, he had carefully examined the unpublished observations on which the previous notice was founded, with a view to ascertain what might be the numerical discrepancy which they present from Fresnel's Theoretical Law. The variation in the results of experiment for each of the angles was very considerable, arising from a multitude of causes as yet imperfectly estimated, but which appear to have been encountered by other observers, who, since that time, have undertaken the same research. Under the circumstances, the mean of the whole observations made between November 1838 and March 1839, have been taken for each angle of incidence; and the results being projected in the usual manner, the angles of incidence forming the line of abscissæ, and the intensities the ordinates, an interpolating curve was drawn through the whole. The numbers thus obtained (which are presented as only a rude first approximation), are shown in the following table, and compared with Fresnel's Formula, calculated for an index of refraction of 1·50.

Incidence.	Proportion of Heat Reflected.	Fresnel's Numbers, when $\mu = 1{\cdot}50$.
0°	·038	·040
10	·040	·040
20	·044	·040
30	·051	·042

Incidence.		Proportion of Heat Reflected.		Fresnel's Numbers, when $\mu = 1{\cdot}50$.
40°	......	·060	......	·046
50	......	·076	......	·058
60	......	·105	......	·089
70	......	·185	......	·171
80	......	·433	......	·388
85	......	·68	......	·613
90	......	1·00	......	1·000

The results of experiment are generally in excess. This may be due to the impossibility of obtaining rays of heat quite parallel from terrestrial sources. To avoid this and other difficulties, experiments have recently been made in Germany by M. Knoblauch, and in Paris by MM. Provostaye and Depains. The results of the last named observers are very conclusive in favour of the accuracy of Fresnel's law. Their memoir had not reached the author of this paper until his calculations were almost completed.

3. On the solution of certain Differential Equations. By Professor Kelland.

Until recently, general solutions of several classes of equations, such as that which occurs in the theory of the figure of the earth, could not be arrived at. An ingenious transformation lately rendered it a matter of comparative ease to arrive at a solution of these equations in those forms in which they are presented in the solution of physical problems; but still much remains to be done. The object of the present paper is to supply some portion of the deficiency in this respect, by the introduction of a new transformation, and the adoption of the function Γ. The solutions thus obtained are perfectly general, and are arrived at with the greatest facility.

The Most Noble the Marquis of Tweeddale

was duly elected an Ordinary Fellow.

The following Donations to the Library were announced:—

The Astronomical Journal. Vol. I., No. 1. 4to.—*By the Editor.*

Athenæum—Annual Report—General Abstract of Accounts from 1st January to 31st December 1848. 8vo.—*By the Athenæum.*

Twenty-Ninth Report of the Council of the Leeds Philosophical and Literary Society. 1848–49. 8vo.—*By the Society.*

Smithsonian Contributions to Knowledge. Vol. I. Published by the Smithsonian Institution. 4to.

Report, &c. of Smithsonian Institution. 1849. 8vo.—*By the Institution.*

Fauna Antiqua Sivalensis, being the Fossil Zoology of the Sewalik Hills, in the North of India. By Hugh Falconer, M.D., and Proby T. Cautley, F.G.S. Parts I. and IX. Fol.

Do. do. Letter-Press. Part I. 8vo.—*By the Author.*

United States Exploring Expedition during the years 1838, 1839, 1840, 1841, and 1842, under the command of Charles Wilkes, U.S.N. Atlas. Zoophytes. By James D. Dana, A.M. Imp. Fol.—*By the Author.*

Astronomical Observations made at the Royal Observatory, Greenwich, in the year 1847, under the direction of George B. Airy, Esq. 4to.—*By the Observatory.*

Philosophical Transactions of the Royal Society of London for the year 1849. Parts I. and II. 4to.

List of Fellows, &c. of the Royal Society, 30th November 1848. 4to.

Proceedings of the Royal Society. 1848. Nos. 71 and 72. 8vo. *By the Society.*

Monday, 7th January 1850.

Sir THOMAS M. BRISBANE, President, in the Chair.

The following Communications were read:—

1. On the Muscular Substance of the Tongue. By Mr Zaglus. Communicated by Professor Goodsir.

Professor Goodsir communicated an abstract of a paper by Mr Zaglus on the muscular structure of the tongue. The author of the paper had found the muscular substance of the tongue to consist of a cortical

layer, which surrounds the organ on all sides, except its posterior attachment, and in the middle line of its inferior surface.

The cortex consists of a complicated network of fibres, derived from the hyoglossi, styloglossi, lingualis, chondroglossi, and a pair of new muscles, named by the author Notoglossi. The minute details of the arrangement of these muscles have now been ascertained by the author, and their actions in producing the peculiar volubility of the organ.

The cavity of the cortex is occupied by a medulla of transverse and perpendicular muscles, some of which are limited to the cavity itself; others pass into it from without.

The transverse system consists of transversales proprii, with the palatoglossi and glossopharyngei, the perpendicular of external or proper, perpendicular muscles, and internal or geneoglossi.

The transverse and perpendicular muscles are arranged in the medulla, in transversely parallel laminæ, which consist alternately of perpendicular and transverse systems, which pass through the muscles of the cortex to the mucous membrane.

It was also stated, that the human tongue and the ruminant form two types, the latter presenting root, body, and tip, the former wanting the tip. These two types, also, differ in the former possessing, and the latter wanting, a mesial fibro-cartilaginous septum.

2. On the Volcanic Formations of the Alban Hills, near Rome. By Professor J. D. Forbes.

The author thus sums up the general results of his memoir:—

"In the first place, it appears that the Alban volcano (for it is essentially one) has acted throughout a great period of time; for not only has it evidently repeatedly changed its form and materials of eruption, but it is surrounded by knolls of basaltic formations which seem to indicate very ancient and very repeated ejections, without taking the regular form of craters. Such are probably Monte Algido, Civita Lavinia, Monte Giove (Corioli), the Capuccini of Albano, Rocca Priore, Colonna, and perhaps even Capo di Bove, and several open craters, such as one a little below Albano, the Lago Cornufelle near Frascati, the Lake of Gabii, and one near Colonna,

which, on the authority of Ponzi, appear to have ejected peperino. The horse-shoe form of the old crater of the Alban Mount, which, whether formed by the elevation process or not, appears to be composed of beds of basalt, lapilli, tuff, or peperino, and here and there of the lava called *Sperone*, gave way, like that of Somma, on the western or seaward side, and I cannot but think it in no small degree probable, that the vast lava beds which lie under Nemi and Genzano, and which dip at a small angle under Monte Cavo, are part of the dislocated walls of the ancient crater displaced by the convulsion which rent it on the western side, and which was accompanied by a prodigious fluid discharge of peperino, which then formed the strata of La Riccia and Albano, and which, overwhelming the broken-down wall of the ancient crater, formed at the same time the Monte Gentile, and the peperino beds above Nemi. This is confirmed by the prodigious lava blocks imbedded in these rocks, which bespeak the violence of the convulsion during which they were formed. Ages later, the present summit of Monte Cavo and the crater of the Campo d'Annibale were formed, and the latter gave out its currents of *tefrine* or grey basalt, and raised the crater of La Tartaruga and others in the valley of La Molara, and in the central crater; at the same time ejecting great volumes of pulverulent lapilli. It may have been coeval with these perfectly regular and comparatively modern eruptions, or it may have preceded them, that, after a period so long that the surface of the ancient eruptions of peperino were covered with vegetation and timber, the tremendous outbursts which forced open the craters of Albano and Nemi took place, the former producing some slight ejections of peperino or boiling mud, near Castel Gaudolfo; and at the same time a separate orifice, opening at the foot of Monte Cavo, may have discharged into the valley of Marino the remarkable variety of peperino described in this paper, and containing vegetable stems. A long, perhaps even a final, repose succeeded this paroxysm. Even from the very dawn of Italian history these scenes of previous turmoil and desolation appear to have enjoyed profound tranquillity, and to have been immemorially covered with impenetrable groves sacred to the sports of Diana.

"It will be seen, then, that we admit tufas or peperinos of three very different periods, one of which is coeval with, or even anterior to, the formation of the exterior cone, another largely developed, which

accompanied the great breach in it towards the sea; and a third, which probably produced some local streams, such as that of Marino, which has evidently flowed since the ground took its present configuration, and was covered with plants. Of lavas, likewise, we must admit at least three periods; 1*st*, the compact basalts of the outer circuit, which, if Von Buch's theory be correct, have flowed under a less inclination than they at present have; 2*dly*, The well-marked leucitic, or partridge-eyed lavas, which form the interior circuit; and, 3*dly*, the compact basaltic lava which flows past Rocca di Papa towards Gròtta Ferrata, which is possibly coeval with the dikes occurring at Capo di Bove and elsewhere. This leaves the origin of the *lava sperone* still uncertain. It is undoubtedly one of the more recent products, for it not only overlies the whole of the old basaltic series at Tusculum and Nemi, but the leucitic lavas of the newer cone at Rocca di Papa. The easiest solution would be to consider it as a scoriform basalt; but even to this there are difficulties, not only mineralogical, but from position. For how can we connect the mantle-shaped covering of Monte Cavo up to its highest point, with the basalt, which nowhere attains a height (so far as I know) within several hundred feet of it? It is still more difficult to conceive any continuity between the sperone of the central cone and that of Tusculum, which is separated from it by the great valley of La Molara.

The following gentleman was duly elected an Ordinary Fellow:—

W. J. M. Rankine, Esq., C.E.

The following Donations to the Library were announced:—

The Phenomena Diosemeia of Aratus, translated into English verse, with Notes. By John Lamb, D.D. 8vo.—*By the Author.*

Abstract of Exposition on the Strength of Materials. Read before the Royal Scottish Society of Arts at the request of the Council. By George Buchanan, F.R.S.E. 8vo.—*By the Author.*

Sopra alcuni punti della Teoria del Moto dei Liquidi. Memoria del Prof. P. Tardy. 4to.—*By the Author.*

Annalen der K. Sternwarte bei München, herausg. von Dr J. Lamont. Bde. 1 & 2. 8vo.—*By the Observatory.*

Journal of the Asiatic Society of Bengal. Edited by the Secretaries. Nos. 204 and 205. 8vo.—*By the Editors.*

Journal of Agriculture and Transactions of the Highland and Agricultural Society of Scotland. No. 27, N. S., January. 8vo. —*By the Society.*

Mémoires de l'Académie R. des Sciences, &c. de Belgique. Tom. XXVIII. 4to.

Annuaire de l'Académie R. des Sciences, &c., de Belgique. Tom. XV., 2me partie. Tom. 16me, 1re partie. 8vo.—*By the Academy.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. II. 1850. No. 36.

Monday, January 21, 1850.

Dr CHRISTISON, V.P., in the Chair.

The following Communications were read:—

1. On the Gamboge Tree of Siam. By Dr Christison.

Although Gamboge has been known in European commerce for nearly two centuries and a half, and its applications in the arts have been extended in recent times, the tree which produces it is still unknown to botanists.

The late Dr Graham, in 1836, was the first to describe accurately a species of Garcinia, which inhabits Ceylon, and which is well known there to produce a sort of Gamboge, not, however, known in the commerce of Europe. Resting on a peculiarity in the structure of the anthers, which are circumscissile, or open transversely by the separation of a lid on the summit, he constituted a new genus for this plant, and called it *Hebradendron cambogioides*. At the same period the Author examined the properties of this Gamboge, and found that it possesses the purgative action of the commercial drug in full intensity, and that the two kinds agree closely also, though not absolutely, in chemical constitution.

At an earlier period Dr Roxburgh described, in his "Flora Indica," another species of Garcinia, under the name of *Garcinia pictoria*, which inhabits the hills of Western Mysore, and which also

was thought to produce a sort of Gamboge of inferior quality. In 1847 specimens of the tree and its exudation were obtained near Nuggur on the ghauts of Mysore by Dr Hugh Cleghorn of the East India Company's service; and the author, on examining the Gamboge, found it all but identical with that of Ceylon in physiological action, in properties as a pigment, and in chemical constitution. The same plant, with its Gamboge, was about the same time observed by the Rev. F. Mason, near Mergui in Tavoy, one of the ceded Burmese provinces.

A third species, inhabiting the province of Tavoy, and also producing a kind of Gamboge, was identified by Dr Wight in 1840 with Dr Wallich's *Garcinia elliptica*, from Sylhet, on the north-east frontier of Bengal. Its exudation was long thought to be of low quality. But, although this substance has not yet been examined chemically, it has been stated by Mr Mason to be, in his opinion, quite undistinguishable as a pigment from Siam Gamboge.

It is a matter of doubt whether Graham's character is sufficiently diagnostic to be a good generic distinction. But it was shewn by Dr Wight in 1840, that a well characterised section at least of the genus Garcinia consists of species which have "sessile anthers, flattened above, circumscissile, and one-celled;" and that all these species, and no others, appear to exude a gum-resin differing probably very little from commercial Gamboge.

Still the tree which produces Siam Gamboge, the finest and only commercial kind, continues unknown. A strong presumption however arose, that the last species was the Siam tree, as it grows in the same latitude with the Gamboge district of Siam, and not above 200 miles farther west. But if the information recently communicated to the author be correct, the Siam tree is a fourth distinct species of the same section. In December last he received from Mr Robert Little, surgeon at Singapore, specimens taken from two trees which were cultivated there by Dr Almeida, a resident of the colony, and which were obtained by him "direct from Siam" as the Gamboge tree of that country. These specimens are not such as to allow of a complete description; yet they are sufficient to shew that the plant presents the characters of Wight's Gamboge-bearing section of the genus Garcinia; but that it is not any of the species hitherto so fully described as to admit of comparison with it. The fruit is round, not grooved, crowned by a four-lobed knotty stigma,

and surrounded by numerous sessile or subsessile aborted anthers, and by a persistent calyx of four ventricose fleshy sepals. The male flowers consist of a calyx of the same structure, a corolla of four ventricose fleshy petals, and a club-shaped mass of about forty subsessile anthers, closely appressed, connected only at the mere base, one-celled, flattened at the top, and opening by a circular lid along a line of lateral depressions; and there is no appearance of an aborted ovary amidst them. These are the characters of the three species presently known. These three species very closely resemble one another in general appearance and special characters. The new species presents the same close resemblance to them all; and, in particular, its foliage is undistinguishable from that of *Garcinia elliptica*, the leaves being elliptic, acuminate, and leathery, exactly as described and delineated by Wight. But it differs from them all in the male flowers and fruit being peduncled. The male flowers are fascicled, and have a slender peduncle three-tenths of an inch in length. The single young fruit attached to one of the specimens has a thick fleshy peduncle, like an elongated receptacle, half as long as the male peduncle. All the other species hitherto described have both male and female flowers sessile or subsessile. As this difference cannot arise from a mere variation in the same species, the plant must be a new one. The evidence however that it produces Gamboge, and more especially the commercial Gamboge of Siam, is not yet complete; and, until further information on this point be obtained, which the author expects to receive in the course of the year, it appears advisable not to attach to it a specific name. A question may even arise whether the male flowers and the fruit here described may not belong to two species instead of one; but this is far from probable.

2. Notice respecting a Deposit of Shells near Borrowstounness. By Charles Maclaren, Esq.

This deposit of shells is situated about a mile and a half west from Borrowstounness, where the Carse of Falkirk terminates in a strip of flat land a furlong in breadth. The shells are exposed in two openings, each about 300 feet long, made in the soil to procure limestone for Mr Wilson's iron-works. The bed can be traced in these openings along lines having an aggregate length of 1000 feet. Over all that space the shells form an unbroken stratum of

very uniform depth (nearly three inches), and almost perfectly horizontal. They are covered by a bed of dark-brown sandy clay, from two to three feet thick, and rest on a deposit of the same substance, which closely resembles the mud spread over the present beach. The shells are all of one species, the cockle, or *Cardium edule*, and of various sizes down to the most minute. They are mixed with a portion of the clay which covers them, but lie so compactly, that they present to the eye the appearance of a layer of chalk nodules. Very few of them are fractured, and the two valves are generally united. The openings reach within 12 or 15 yards of the high-water line; but the number of broken shells seen on the beach shews that the bed had once extended farther northward, and that part of it has been cut away by the sea. The bed is at present about the level of high water, or a little above it, while the natural abode of the cockle, according to Mr Broderip, is from the low-water line to a depth of 13 fathoms. The continuity of the bed, its regular level, its remarkable uniformity, its composition confined to a single species, and the state of the shells, which are generally entire, and have the two valves united, shew that they are in their native locality, and prove that they could only have been brought to their present position by an upheaval of the land. This upheaval must have been to the extent at least of 18 feet, which is the difference betwixt high and low water, but very probably it was to the extent of 20, 30, or 40 feet. Inundations of the sea, caused by storms, have been called in to account for such deposits, but in my opinion very inconsiderately. That a sudden and violent movement of the sea should sweep away a bed of shells from its original locality, is intelligible enough; but that, while transporting them over some hundred feet or yards, it should preserve them unbroken, with the valves still united,—that the rushing water, instead of ploughing up the dry land it invaded, should smooth and level an area of more than an acre, then spread out the shells upon it with mathematical regularity, in an uninterrupted stratum of nearly uniform depth,—that, finally, it should cover them with a bed of clay two or three feet thick, and then withdraw;—these seem to me to be effects utterly irreconcileable with the known agency of floods. I would as soon believe that the West India hurricane, instead of levelling the planter's house, transports it *en masse*, with it walls, roof, and furniture all entire, from one end of a field to the other.

3. An Account of some Monstrosities. By the late Dr J. Reid. Communicated by Prof. Goodsir.

4. The Effect of Pressure in Lowering the Freezing-Point of Water experimentally demonstrated. By Professor W. Thomson, Glasgow.

On the 2d of January 1849, a communication, entitled "Theoretical Considerations on the Effect of Pressure in Lowering the Freezing-Point of Water, by James Thomson, Esq., of Glasgow," was laid before the Royal Society, and it has since been published in the *Transactions*, Vol. XVI., Part V. In that paper it was demonstrated that, if the fundamental axiom of Carnot's Theory of the Motive Power of Heat be admitted, it follows, as a rigorous consequence, that the temperature at which ice melts will be lowered by the application of pressure; and the extent of this effect due to a given amount of pressure was deduced by a reasoning analogous to that of Carnot from Regnault's experimental determination of the latent heat, and the pressure of saturated aqueous vapour at various temperatures differing very little from the ordinary freezing-point of water. Reducing to Fahrenheit's scale the final result of the paper, we find

$$t = n \times 0{\cdot}0135 ;$$

where t denotes the depression in the temperature of melting ice produced by the addition of n "atmospheres" (or n times the pressure due to 29·922 inches of mercury), to the ordinary pressure experienced from the atmosphere.

In this very remarkable speculation, an entirely novel physical phenomenon was *predicted* in anticipation of any direct experiments on the subject; and the actual observation of the phenomenon was pointed out as a highly interesting object for experimental research.

To test the phenomenon by experiment without applying excessively great pressure, a very sensitive thermometer would be required, since for ten atmospheres the effect expected is little more than the tenth part of a Fahrenheit degree; and the thermometer employed, if founded on the expansion of a liquid in a glass bulb and tube, must be protected from the pressure of the liquid, which, if acting on it,

would produce a deformation, or at least a compression of the glas that would materially affect the indications. For a thermometer of extreme sensibility, mercury does not appear to be a convenient liquid; since, if a very fine tube be employed, there is some uncertainty in the indications on account of the irregularity of capillary action, due probably to superficial impurities, and observable even when the best mercury that can be prepared is made use of; and again, if a very large bulb be employed, the weight of the mercury causes a deformation which will produce a very marked difference in the position of the head of the column in the tube according to the manner in which the glass is supported, and may therefore affect with uncertainty the indications of the instrument. The former objection does not apply to the use of any fluid which perfectly wets the glass; and the last-mentioned source of uncertainty will be much less for any lighter liquid than mercury, of equal or greater expansibility by heat. Now the coefficient of expansion of sulphuric ether, at 0° C., being, according to *M*. I. Pierre,* ·00151, is eight or nine times that of mercury (which is ·000179, according to Regnault); and its density is about the twentieth part of the density of mercury. Hence a thermometer of much higher sensibility may be constructed with ether than with mercury, without experiencing inconvenience from the circumstances which have been alluded to. An ether thermometer was accordingly constructed by Mr Robert Mansell of Glasgow, for the experiment which I proposed to make. The bulb of this instrument is nearly cylindrical, and is about $3\frac{1}{2}$ inches long and $\frac{3}{8}$th of an inch in diameter. The tube has a cylindrical bore about $6\frac{1}{2}$ inches long: about $5\frac{1}{2}$ inches of the tube are divided into 220 equal parts. The thermometer is entirely enclosed, and hermetically sealed in a glass tube, which is just large enough to admit it freely. On comparing the indications of this instrument with those of a thermometer of Crichton's with an ivory scale, which has divisions, corresponding to degrees Fahrenheit, of about $\frac{1}{25}$th of an inch each; I found that the range of the ether thermometer is about 3° Fahrenheit; and that there are about 212 divisions on the tube corresponding to the interval of pressure from 31° to 34°, as nearly as I could discover from such an unsatisfactory standard of reference. This gives $\frac{1}{71}$ of a degree

* See Dixon on Heat, p. 72.

for the mean value of a division. From a rough calibration of the tube which was made, I am convinced that the values of the divisions at no part of the tube differ by more than $\frac{1}{80}$th of this amount, from the true mean value ; and, taking into account all the sources of uncertainty, I think it probable that each of the divisions on the tube of the ether thermometer corresponds to something between $\frac{1}{68}$ and $\frac{1}{75}$ of a degree Fahrenheit.

With this thermometer in its glass envelope, and with a strong glass cylinder (Œrsted's apparatus for the compression of water), an experiment was made in the following manner :—

The compression vessel was partly filled with pieces of clean ice, and water : a glass tube about a foot long and $\frac{1}{10}$th of an inch internal diameter, closed at one end, was inserted with its open end downwards, to indicate the fluid pressure by the compression of the air which it contained : and the ether thermometer was let down and allowed to rest with the lower end of its glass envelope pressing on the bottom of the vessel. A lead ring was let down so as to keep free from ice the water in the compression cylinder round that part of the thermometer tube where readings were expected. More ice was added above, so that both above and below the clear space, which was only about two inches deep, the compression cylinder was full of pieces of ice. Water was then poured in by a tube with a stopcock fitted in the neck of the vessel, till the vessel was full up to the piston, after which the stopcock was shut.

After it was observed that the column of ether in the thermometer stood at about 67°, with reference to the divisions on the tube, a pressure of from 12 to 15 atmospheres was applied, by forcing the piston down with the screw. Immediately the column of ether descended very rapidly, and in a very few minutes it was below 61°. The pressure was then suddenly removed, and immediately the column in the thermometer began to rise rapidly. Several times pressure was again suddenly applied, and again suddenly removed, and the effects upon the thermometer were most marked.

The fact that the freezing-point of water is sensibly lowered by a few atmospheres of pressure, was thus established beyond all doubt. After that, I attempted, in a more deliberate experiment, to determine as accurately as my means of observation allowed me to do, the actual extent to which the temperature of freezing is affected by determinate applications of pressure.

In the present communication, I shall merely mention the results obtained, without entering at all upon the details of the experiment.

I found that a pressure of, as nearly as I have been able to estimate it, 8·1 atmospheres produced a depression measured by $7\frac{1}{2}$ divisions of the tube, on the column of ether in the thermometer; and again, a pressure of 16·8 atmospheres produced a thermometric depression of $16\frac{1}{2}$ divisions. Hence the observed lowering of temperature was $\frac{7\frac{1}{2}}{71}$, or ·106° F. in the former case, and $\frac{16\frac{1}{2}}{71}$, or ·232° F. in the latter.

Let us compare these results with theory. According to the conclusions arrived at by my brother in the paper referred to above, the lowering of the freezing-point of water by 8·1 atmospheres of pressure would be 8·1 × ·0135, or ·109° F.; and the lowering of the freezing-point by 16·8 atmospheres would be 16·8 × ·0135, or ·227° F. Hence, we have the following highly satisfactory comparison, for the two cases, between the experiment and theory.

Observed Pressures.	Observed Depressions of Temperatures.	Depressions according to Theory, on the hypothesis that the Pressures were truly observed.	Differences.
8·1 Atmospheres.	·106° F.	·109° F.	− ·003° F.
16·8 Atmospheres.	·232° F.	·227° F.	+ ·005° F.

It was, I confess, with some surprise, that, after having completed the observations under an impression that they presented great discrepancies from the theoretical expectations, I found the numbers I had noted down indicated in reality an agreement so remarkably close, that I could not but attribute it in some degree to chance, when I reflected on the very rude manner in which the quantitative parts of the experiment (especially the measurement of the pressure, and the evaluation of the division of the ether thermometer) had been conducted.

I hope, before long, to have a thermometer constructed, which shall be at least three times as sensitive as the ether thermometer I have used hitherto; and I expect with it to be able to perceive the effect of increasing or diminishing the pressure by less than an atmosphere, in lowering or elevating the freezing-point of water.

If a convenient *minimum* thermometer could be constructed, the effects of very great pressures might easily be tested by hermetically sealing the thermometer in a strong glass, or in a metal tube, and putting it into a mixture of ice and water, in a strong metal vessel, in which an enormous pressure might be produced by the forcing pump of a Bramah's press.

In conclusion, it may be remarked, that the same theory which pointed out the remarkable effect of pressure on the freezing-point of water, now established by experiment, indicates that a corresponding effect may be expected for all liquids which expand in freezing; that a reverse effect, or an elevation of the freezing-point by an increase of pressure, may be expected for all liquids which contract in freezing; and that the extent of the effect to be expected may, in every case, be deduced from Regnault's observations on vapour (provided that the freezing-point is within the temperature-limits of his observations), if the latent heat of a cubic foot of the liquid, and the alteration of its volume in freezing be known.

5. On the Extinction of Light in the Atmosphere. By W. S. Jacob, Esq., H.E.I.C. Astronomer, Madras. Communicated by Prof. C. Piazzi Smyth.

In a letter dated Madras, November 1849, Captain Jacob says, " I have been much interested in reading, lately, Professor Forbes's paper in the Philosophical Transactions, 1842, Part 2, on the Extinction of Light and Heat in the Atmosphere." As his results agree very closely with those of my experience on the Trigonometrical Survey of India, and which, though not founded on any precise measures, being still the conclusions of some years' experience, are perhaps worth noticing, particularly when they agree with the results of more exact measures.

On commencing work with heliotropes in 1837, I soon found that for long distances it was necessary to enlarge the apertures *more* than in the simple ratio of the distance (though such was Colonel Everest's practice); and before the end of the first season, I had formed a scale of apertures for corresponding distances, which afterwards needed very little alteration, but when finally corrected by subsequent years' observation, stood as follows :—

Aperture. Inches.	Maximum Distance. Miles.	Maximum Distance without Absorption.
0·5	15	15
1·0	23	30
2·0	33	60
4·0	45	120
8·0	60	240

Our heliotropes were circular glass mirrors, 8 inches in diameter; and for the smaller apertures, diaphragms were used between the heliotropes and the observer. At the distances stated the light was just visible to the naked eye in clear weather, and when seen over a *valley:* if the ray *grazed* near the surface, the light was much reduced. On one occasion I employed a heliotrope at 6¼ miles, and used an aperture of ⅛ of an inch, and found it rather brighter than usual, so that probably 6½ or 7 miles would be the normal distance for that size.

This agrees well enough with the rest of the scale, but there is no need to employ a conjectural quantity; and if the rate of absorption corresponding to the above be computed, so close an agreement will be found, as may entitle the numbers to be looked on as something better than mere estimates,—as the results, indeed, of a species of observation.

The mean of the whole shews a loss of ·0610 in passing through one mile of atmosphere; with the barometer at 27·0 inches (that being about the average height of my stations), but reduced to 30·0 inches, the quantity will be ·0671.

Hence the loss of light in passing from the zenith through a homogeneous atmosphere of 5·2 miles will be ·303, or only about one per cent. less than Professor Forbes's result. And as my air was considerably drier than his (the mean humidity being not much above ·30 instead of ·56), this will probably account for the difference; and, at any rate, the agreement is much closer than could have been expected.

I once mentioned this matter to Captain Waugh, the present Surveyor-General of India, then my fellow-assistant; but he not only had not noticed the thing, but did not even apprehend my meaning. He assented to my remark on the *loss* of light in passing through the atmosphere, but asserted that the aperture should vary as the distance, thus allowing for *no* loss! 0·1 inch per mile answered,

he said, for all distances that he had tried! So it might answer for the distances most usually occurring on the Survey; for 4 inches would be proper for 40 miles, and 2 inches not much too bright at 20, and it is not often that these limits would be passed. Yet it is hardly possible to conceive that he should not have noticed the different intensity of the lights; had not his opportunities been perhaps rather unfavourable, as his work lay chiefly in plains, where, as mentioned above, the light of a grazing ray is very much reduced, and the atmospheric effect would therefore be mixed up with disturbing local causes.

I myself was much astonished at first discovering that the air had so great absorbent powers, and many ideas are suggested by the fact. We see at once how easily many of the planets may be rendered habitable to beings like ourselves. Mars, *e. g.*, may enjoy a temperature little inferior to our own, by having a *less* absorbent envelope; and Venus may be kept as cool as we are, by having one *more* so.

The following Gentlemen were duly elected Ordinary Fellows:—

Mr Alex. K. Johnston.
Dr John Scott, F.R.C.P.
Dr Sheridan Muspratt, Liverpool.

The following Donations to the Library were announced:

Annuaire Magnétique et Météorologique du Corps des Ingénieurs des Mines; ou Recueil d'Observations Météorologiques et Magnétiques faites dans l'entendue de l'empire du Russie, par A. T. Kupffer. Nos. 1 & 2, 1849. 4to.—*By the Russian Government.*

Verhandelingen der Eerste Klasse van het K. Nederlandsche Instituut van Wetenschappen, Letterkunde, en Schoone Kunsten te Amsterdam. 3de Reeks, Deel 1, Stuk 3 en 4. 4to.

Tijdschrift voor de Wis-en Natuurkundige Wetenschappen uitgegeven door de Eerste Klasse van het K. Nederlandsche Instituut van Wetenschappen te Amsterdam. 3de Deel, 1 & 2 Afleverings. 8vo.—*By the Academy.*

Jaarboek van het K. Nederlandsche Instituut van Wetenschappen, Letterkunde, en Schoone Kunsten te Amsterdam, 1847, 1848, 1849. 8vo.—*By the Academy.*

Catalogue of 2156 Stars, formed from the Observations made during Twelve Years, from 1836 to 1847, at the Royal Observatory, Greenwich. 4to.—*By the Royal Society, Lond.*

Proceedings of the Philosophical Society of Glasgow, 1848–9. Vol. III., No. 1. 8vo.—*By the Society.*

Quarterly Journal of the Chemical Society of London. No. 8. 8vo. *By the Society.*

Proceedings of the Royal Astronomical Society. Vol. X., No. 2. 8vo. —*By the Society.*

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. II. | 1850. | No. 37.

Monday, 4th February 1850.

The Hon. Lord MURRAY in the Chair.

The following Communications were read :—

1. Abstract of a Paper on the Hypothesis of Molecular Vortices, and its Application to the Mechanical Theory of Heat. By William John Macquorn Rankine, Civil Engineer, F.R.S.E., F.R.S.S.A., &c.

The object of this paper is to shew how the laws of the phenomena of Elasticity and Expansion, as connected with heat, may be reduced to mechanical principles by means of an hypothesis called that of Molecular Vortices.

The author ascribes the first distinct statement of an hypothesis of this kind to Sir Humphrey Davy, and refers to Mr Joule as having supported it; but he states that its consequences, to the best of his knowledge, have not hitherto been developed by means of the principles of Analytical Mechanics.

The author has endeavoured to do this, so far as the present state of experimental knowledge enables him, introducing such modifications into the hypothesis as are necessary in order to connect it with the undulatory theory of radiation. His researches were commenced in 1842, but were laid aside for nearly seven years from the want of experimental data, which, however, have at length been to a great extent supplied, so far as gaseous bodies are concerned, by the ex-

periments of M. Regnault. The author has thus been enabled to resume his investigations, and has obtained formulæ, agreeing with experiment, and applicable to practice, for the expansion and elasticity of gases,—the elasticity of vapours in contact with their liquids,—the specific heat of gases,—tho heat produced by their compression,—the latent and total heat of evaporation,—the expansive action of vapours,—the power of the steam-engine,—and the mechanical value of heat in general.

One of the most useful in practice of those formulæ,—that for calculating the elasticity of steam and other vapours in contact with their liquids,—was published separately in the Edinburgh New Philosophical Journal for July 1849, with tables and a diagram, shewing its agreement with experiment, but without any account of the reasoning from which it is deduced.

The theory of radiant heat, like that of light, having been reduced to a branch of mechanics by means of the hypothesis of undulations, it is the object of the hypothesis of Molecular Vortices to reduce the theory of stationary heat also to a branch of mechanics, and thus to make a further step towards the fulfilment of the wish of Newton,—"UTINAM CÆTERA NATURÆ PHÆNOMENA EX PRINCIPIIS MECHANICIS DERIVARE LICERET."

The hypothesis of molecular vortices is defined to be that which assumes, *that each atom of matter consists of a nucleus or central point, enveloped by an elastic atmosphere, which is retained in its position by attractive forces, and that the elasticity due to heat arises from the centrifugal force of those atmospheres, revolving or oscillating about their nuclei or central points.* According to this hypothesis, *quantity of heat is the* vis viva *of the molecular revolutions or oscillations.*

The author, for the present, leaves indeterminate the following questions, as he has not as yet found it necessary to make any definite supposition respecting them.

First, Whether the elastic molecular atmospheres are continuous, or consist of discrete particles? This includes the question, Whether expansive elasticity is wholly the result of the mutual repulsions of particles, or is, to a certain extent, a primary quality of matter?

Secondly, Whether, at the centre of each atom, there is a real *nucleus* or extremely small central body, or a mere *centre* of condensation and force?

Thirdly, What are the figures of the orbits described by the particles of the atomic atmospheres in their revolutions or oscillations?

The author introduces into the hypothesis of molecular vortices a supposition peculiar to his own researches, for the purpose of connecting it with the undulatory hypothesis as to radiation. It is this: *That the vibration which, according to the undulatory hypothesis, constitutes radiant light and heat, is a motion of the atomic nuclei or centres, and is propagated by means of their mutual attractions and repulsions.* The absorption of light and of radiant heat, according to this supposition, is the transference of motion from the nuclei or centres to their atmospheres, and the emission of light and radiant heat, the transference of motion from the atmospheres to the nuclei or centres. The author enumerates several advantages which he conceives that this hypothesis possesses over the common supposition of a luminiferous ether pervading the spaces between ponderable particles.

The present paper refers solely to the condition of bodies in the state of gas or vapour. It is divided into two parts, the first of which treats of the Statical Relations of Heat and Elasticity, or their relations when both are invariable; and the second, of their Dynamical Relations, which take place when gaseous bodies expand or contract, and involve the principles of the mutual conversion of heat and expansive power, and those of the latent heat of expansion and evaporation.

The first section of the first part explains the general principles of the hypothesis, of which a summary has just been given.

The second section contains the mathematical investigation of the general equation between the heat and the elasticity of a gas. The total elasticity is divided into two parts, — the *superficial atomic elasticity*, being the elasticity of the atomic atmospheres at the bounding surfaces of the atoms, which is always expansive, and a function of density and heat, and an elasticity arising from the mutual forces exerted by separate atoms, which may be expansive or contractive, and in the perfectly fluid state is a function of density only.

The more substances are rarefied, that is to say, the more the forces which interfere with the operation of the elasticity of the atomic atmospheres are weakened, the more nearly do they approach to a condition called that of perfect gas, in which the total elasticity

at a given temperature, is simply proportional to the density. This is therefore assumed to be the law of the elasticity of the atomic atmosphere of any given substance; so that the superficial atomic elasticity is held to be proportional to the density of the atomic atmosphere, at its bounding surface.

It is shewn, that although the form of such bounding surfaces in a perfect fluid is a rhombic dodecahedron, it may be treated without sensible error, in calculation, as if it were spherical, and the atmosphere of each atom may be conceived to be composed of concentric spherical layers, the density being uniform for each layer, but varying for different layers.

An oscillatory movement is supposed to be propagated from the nucleus or atomic centre in an inappreciably short time, to every part of the atmosphere, so that the mean velocity of movement is uniform throughout. The quantity of heat in one atom, or any other mass of matter, is expressed in terms of the force of gravity, by the weight of that mass, multiplied by the height through which it must fall at the earth's surface, in order to acquire that velocity. This oscillatory movement is conceived to be resolved into two components, one in the direction of radii passing through the atomic centre, the other performed in spherical surfaces described round that centre. The latter component alone produces centrifugal force; and it is afterwards shewn to be probable, that the ratio which the *vis viva* of this latter component bears to the whole *vis viva* of the oscillations, depends on the chemical constitution of the substance. The centrifugal force thus arising, has a tendency to increase the superficial density and elasticity of the atomic atmosphere, and must, at each layer of that atmosphere, be *in equilibrio* with the forces arising from the elastic pressure of the adjacent layers, and from the attraction towards the nucleus or centre. The condition of this equilibrium is expressed by a differential equation, which at the same time shews it to be stable. By the integration of that equation, there is obtained a general expression for the elasticity of a gas, in terms of its density and heat.

The first and largest term is simply proportional to the density of the gas, multiplied by a function, which varies as a certain fraction of the heat increased by a constant. In a perfect gas, this term constitutes the whole elasticity.

It is followed by an approximative converging series, chiefly ne-

gative, in terms of the reciprocals of the powers of the function of the heat before mentioned, representing the effect of the actions of the nuclei or centres in modifying the superficial-atomic elasticity. The numerators of the terms of this series are functions of the density, diminishing along with it, and requiring to be determined by experiment.

The last term of the expression represents the effect of the mutual action of separate atoms, and is a function of the density, to be determined by experiment.

The third section treats of Temperature and of Real Specific Heat. Bodies are defined to be *at the same temperature*, when the powers of their atoms to communicate heat are equal; and the proper *measure* of temperature is defined to be the elasticity of a perfect gas at constant volume, or its volume under constant pressure. Those quantities are, in all perfect gases, proportional to the temperature, as measured from a point 274·6 centigrade degrees, or 494·28 degrees of Fahrenheit's scale, below the temperature of melting ice. This point is called the *absolute zero*, and temperatures, as measured from it, *absolute temperatures*.

It is shewn from the equations in the preceding section, that absolute temperature, as thus defined, is simply proportional to the quantity of heat in one atom, *plus* a constant, multiplied by a constant coefficient. The constants depend on the nature of the substance, and the coefficient especially on its chemical constitution.

The reciprocal of this coefficient is, of course, the *real specific heat of one atom*, which, being divided by the atomic weight, gives the *real specific heat of unity of weight*.

The following laws, which have been to a great extent established experimentally by Dulong, are inferred from the theory—

That the specific heats of all simple atoms are either the same, or vary only in certain simple numerical ratios.

That the specific heats of atoms of similar chemical constitution are either the same, or vary only in simple numerical ratios.

The fourth section relates to the actual coefficients of elasticity and expansion of gases. The coefficient of increase of elasticity with temperature at constant volume, and the coefficient of expansion under constant pressure, are the same, and equal to each other, for every substance in the state of perfect gas, being the reciprocal of the absolute temperature of melting ice, (or ·00364166 per centi-

grade degree), when the volume and pressure at that temperature are respectively taken as units. The state of perfect gas, however, can be only approximated to in nature; for in all gases, especially the more dense and composite, the actions of the atomic nuclei or centres on their atmospheres, and of separate atoms upon each other, have more or less influence on the elasticity.

M. Regnault has made several elaborate series of experiments, to determine the deviations from uniform expansibility thus produced, in various gases.

The author, by applying his theory to data furnished by the experiments of M. Regnault, has obtained formulæ for the coefficients of expansion of atmospheric air, carbonic acid gas, and hydrogen, the results of which agree closely with those of observation, in every case in which a comparison is possible.

The fifth section treats of the elasticity of vapour in contact with the same substance in the liquid or solid state, or what is called the pressure of vapour at saturation.

The equilibrium of a substance filling a limited space, partly in the form of vapour, and partly in that of liquid or solid, is shewn to depend on three conditions.

The first condition of equilibrium is, that the total elasticity of the substance in the two states must be the same.

The second condition of equilibrium is, that the superficial elasticities of every two contiguous atoms must be the same at their surface of contact, and hence, that the superficial-atomic elasticity must vary continuously; so that, if, at the bounding surface between the liquid or solid and its vapour, there is an abrupt change of density, (as the reflection of light renders probable) there must there be two densities corresponding to the same superficial atomic elasticity.

The third condition of equilibrium is deduced from the mutual attractions and repulsions of the atoms of liquid or solid and those of vapour. In a gas in which the atomic centres are equidistant, the actions of the several atoms on each individual particle at an appreciable distance from the bounding surface of the gas, balance each other, and are accordingly treated as merely affecting the total elasticity by a quantity which is a function of the density; but near the bounding surface between a liquid or solid and its vapour, the action of the liquid or solid upon any atom must be greater than that of the vapour. A force is thus produced which acts on each particle in a

line perpendicular to that bounding surface, and which is probably attractive towards the liquid or solid, very intense close to the bounding surface, but inappreciable at all perceptible distances from it. Such a force can be balanced only by a gradual increase of superficial-atomic elasticity in a direction towards the liquid or solid. Hence, although at perceptible distances from the liquid or solid, the density of vapour is sensibly uniform, the layers close to that surface are probably in a state of condensation by attraction, analogous to that of the earth's atmosphere under the influence of gravity.

Professor Faraday has expressed an opinion that certain well-known phenomena arise from a state of condensation of this kind, produced in gases by the superficial attraction of various solid substances.

This third condition of equilibrium is expressed by a differential equation, the integral of which, taken in conjunction with the first two conditions, would be sufficient to determine the respective densities, and the total elasticity of a liquid or solid and its vapour, when in contact with each other in a limited space at any temperature, provided we had a complete knowledge of the laws of molecular force. In the present imperfect state of that knowledge, the integral in question indicates the *form* of an approximate equation, expressing the logarithm of the elasticity of vapour at saturation, in terms of the reciprocals of the first and second powers of the absolute temperature, the coefficients of which the author has calculated empirically, for water and mercury, from the experiments of M. Regnault, and for alcohol, ether, turpentine, and petroleum, from those of Dr Ure,—three experimental data being required for each fluid, to calculate three constants. The agreement of the results of the formulæ thus obtained with those of experiment is as close as the uncertainties of observation render possible, throughout the whole range of pressures and temperatures observed. For steam, in particular, the coincidence is almost perfect. The author gives a table of the constants for the fluids enumerated, and refers to the Edinburgh New Philosophical Journal for July 1849, for the details of the comparison between calculation and experiment.

The section concludes with a speculation as to the probable effects of the atmospheres of dense vapours supposed to exist at the surfaces of solid and liquid bodies. The author conjectures that the presence of such atmospheres may be the cause which prevents solid

bodies from cohering when brought together, and produces that resistance to contact which is visible not only in them but in drops of liquid. He conceives it possible that it may also be the cause of the "spheroidal state" of liquids at high temperatures, and may assist in maintaining the vesicular state, if such a state exists.

The sixth and last section of the first part relates to mixtures of gases and vapours of different kinds.

The principle stated in the second section *that the elasticity of the atomic atmosphere is proportional to its density*, is here expressed in the form, *that the elasticity of any number of portions of atomic atmosphere, compressed into a given space, is equal to the sum of the elasticities which such portions would respectively have if they occupied the same space separately*. It is shewn, that if this principle be considered true, not only of portions of atomic atmosphere of one kind of substance, but also of portions of atomic atmospheres of substances of different kinds, when mixed, it leads to the well-known laws of the elasticity and diffusion of mixed gases and vapours. He also speculates on the possibility of solid bodies, which have no perceptible vapours of their own at ordinary temperatures, acquiring the power of resisting cohesion by means of a superficial atmosphere of foreign substances.

The second part of the paper treats of the dynamical relations of the heat and the elasticity of bodies in the gaseous state.

The first section contains the general theory of the mutual conversion of heat and expansive power.

After recapitulating the mode of expressing quantities of heat in terms of gravity, the author refers to the experiments of Mr. Joule on the production of heat by electro-magnetic currents, by friction, and by the compression of air, as proving the convertibility of heat and mechanical power. He states reasons, however, for believing that the mechanical value of heat as deduced from those experiments (viz., from 760 feet to 890 feet per degree of Fahrenheit, applied to liquid water) is too large, owing to various causes of loss of power, and gives the preference to experiments in which no machinery is used, such as those on the velocity of sound, as data for such a calculation.

The laws of the production of heat by compression, and its consumption by expansion, are then deduced from the following two principles, the first of which is peculiar to the hypothesis of mole-

cular vortices, while the second is a consequence of the law of the conservation of *vis viva*.

First, As every portion of an atomic atmosphere is urged towards the nucleus or atomic centre by a centripetal force equal to the centrifugal force arising from the oscillation which constitutes heat, it follows that, when by compression, each portion of such an atmosphere is made to *approach* the centre by a certain distance, the *vis viva* of its oscillation will be *increased* by the amount corresponding to that centrifugal force, acting through that distance; and conversely, that, when, by expansion, each portion of the atmosphere is made to *retreat from* the centre, the *vis viva* of its motion will be *diminished* by a similar amount.

Secondly, Let a portion of any substance undergo any changes of temperature, volume, and figure, and at length return to its primitive volume, figure, and temperature. Then, the absolute quantity of heat in the substance, the arrangement of the atoms, and the distribution of their atmospheres, being the same as at first, it follows that *the algebraical sum of the* vires vivæ *consumed and produced during the changes, whether in the shape of expansion and compression, or in that of heat, must be equal to zero;* that is to say, if on the whole, a certain amount of mechanical power has appeared, and been given out from the body in the form of expansion, an equal amount must have been communicated to the body, and must have disappeared in the form of heat; and if a certain amount of mechanical power has appeared and been given out from the body in the form of heat, an equal amount must have been communicated to the body, and must have disappeared in the form of expansion.

From those principles the author deduces an algebraical expression of three terms. The first term represents the variation of heat arising from mere change of volume; the second, the variation of heat produced by change of the distribution of the density of the atomic atmospheres dependent on change of volume; and the third, the variation of heat due to change of the distribution of the density of the atomic atmospheres, dependent on change of temperature. In all those terms there is a common factor, bearing a constant ratio to the absolute quantity of heat in the body. In the first term, that factor is multiplied by the variation of the logarithm of the density of the body, and in the second and third by certain functions of the density

and temperature depending on the law of the influence of molecular attraction and repulsion upon the superficial-atomic elasticity.

This section concludes by contrasting the author's theory with that of Carnôt, which has hitherto been followed, either explicitly or virtually, in all calculations respecting the motive power of heat (except in the investigations of Mr Joule, already referred to), and of which a very clear and able account, with copious illustrations, was read before the Royal Society of Edinburgh, in January 1849, by Professor Thomson. Carnôt considers heat to be something of a peculiar kind, whether a condition or a substance, the total amount of which, in nature, is incapable of increase or diminution. It is not, therefore, according to his theory, convertible into mechanical power, but is capable, by its transmission through substances under particular circumstances, of causing mechanical power to be developed which did not before exist. According to the author's theory, on the contrary, as well as to every conceivable theory which regards heat as a modification of motion, the production of expansion by heat, and of heat by compression, consist in the transformation of mechanical power from one shape into another.

The second section relates to real and apparent specific heat, especially in the state of perfect gas. The apparent specific heat of a given substance is defined to be the sum of the real specific heat, and of that heat which is employed in producing those changes of volume and of molecular condition which accompany an elevation of one degree in the temperature of the substance. The same substance may therefore have different apparent specific heats, according to the manner in which the volume is made to vary with the temperature. The general algebraical expression for apparent specific heat is deduced from the equations of the preceding section. That expression being applied to the case of a perfect gas, or of a gas which may be treated in practice as sensibly perfect, it is shewn that the apparent specific heat of such a gas, at constant volume, is sensibly equal to the real specific heat, and that the apparent specific heat at constant pressure exceeds the specific heat at constant volume in a ratio which is sensibly constant for a given gas. Laplace's method of calculating this ratio from the velocity of sound is referred to, and applied to atmospheric air, oxygen, and hydrogen, using the correct coefficients of dilatation of those gases, as determined by M. Regnault.

The following laws, which have already been inferred from experiment by Dulong, are then deduced from the theory :

The specific heat of unity of volume, at constant volume, varies for different perfect gases inversely as the fraction by which the ratio of the two specific heats exceeds unity.

Equal volumes of all substances in the state of perfect gas, at the same pressure, and at equal and constant temperatures, being compressed by the same amount, disengage equal quantities of heat.

The data now obtained being employed to calculate the value of heat in terms of the force of gravity, it is found that the real specific heat of atmospheric air is equivalent to a fall of 238·66 feet per centigrade degree, and the apparent specific heat of liquid water at the temperature of melting ice (being what is commonly termed a thermal unit) to a fall of 1252 feet per centigrade degree, or 695·6 feet per degree of Fahrenheit.

The author next investigates the apparent specific heat of vapour at saturation. This quantity, according to his theory, is altogether different from the variation of the total heat of evaporation, with which, according to the theory of Carnôt, it is identical. It is in general *negative* ; so that if vapour at saturation is allowed to expand, being cut off from external sources of heat, a portion of it must be liquefied in order to supply the heat necessary for the expansion of the rest, in addition to the heat set free by the fall of temperature.

The third section treats of the latent and total heat of evaporation, especially for water.

It is in the first place proved, from the principle of *vis viva*, that the latent heats of evaporation and liquefaction, at a given temperature, are equal, with contrary signs.

The total heat of evaporation is defined to be the sum of the latent heat of evaporation, and of the heat required to raise the liquid to the temperature at which it is evaporated, from some arbitrary fixed temperature—(generally that of melting ice).

The law of variation of the total heat of evaporation with temperature is then deduced from the principle of the conservation of *vis viva*, which, as applied to this subject, takes the following form :—

Let a portion of fluid in the liquid state be raised from a certain temperature to a higher temperature ; let it be evaporated at the higher temperature ; let the vapour then be allowed to expand,

being maintained always at the temperature of saturation for its density, until it is restored to its original temperature, at which temperature let it be liquefied: then the excess of the heat absorbed by the fluid above the heat given out will be equal to the expansive power generated.

From this principle it is deduced that when a vapour is sensibly in the state of perfect gas, and of very small density as compared with its liquid, the total heat of evaporation increases uniformly with the temperature, and the rate of increase is sensibly equal to the apparent specific heat of the vapour at constant pressure. This conclusion is verified by the experiments of M. Regnault upon the evaporation of water. As an additional verification of the theory, the real specific heat of steam is calculated from the total heat of evaporation, and also from the specific heat of atmospheric air; and the results of these two processes are found to agree exactly, being equal to 0·183 of the apparent specific heat of liquid water.

The fourth and last section of the second part is an investigation of the mechanical action of steam, treated as a perfect gas, and the power of the steam-engine.

The density of steam of saturation at 100° centigrade, is calculated from its chemical composition on the assumption of its being a perfect gas, and found to agree with the result of experiment, being $\frac{1}{1696}$ of the maximum density of water; and thence it is inferred that, in the absence of more precise data, steam at ordinary pressures may be treated in practice as a perfect gas, without material error.

The mechanical action of unity of weight of steam while entering a cylinder, and before it has begun to expand, is found by multiplying its pressure by its volume. The expansive action is next investigated, taking into account the liquefaction of a portion of the steam in supplying the heat required to expand the rest. The exact expression of this action is extremely complicated; but approximate formulæ of a more simple kind are given, suitable for calculating its amount with accuracy sufficient for practice, in different portions of the scale of pressures. From the sum of those two portions of power, deductions are made for the loss of power arising from clearance, and for the effect of the counter-pressure of the escaping steam. Thus is obtained the complete expression for the gross effect of unity of weight of steam, which, being multiplied by the weight of water effectively

evaporated in unity of time gives the gross effect of the engine in unity of time. The result affords the means of calculating all the circumstances connected with the working of a steam-engine according to the principle of the conservation of *vis viva*, or, in other words, of the equality of power and effect, which regulates the action of all machines that move with a uniform or periodical velocity. This principle was first applied to the steam-engine by the Count de Pambour, and, accordingly, the formulæ of this paper only differ from those of his work in the expressions for the pressure and expansive action of the steam, which are results peculiar to the author's theory. As an illustration of the use of the formulæ, the maximum useful effect of a double-acting Cornish engine is computed, and compared with the result of the calculation of M. de Pambour for the same engine, shewing the latter to be too large by about one-fifteenth.

In an Appendix are given two tables; one for calculating the volume of steam from its pressure, and *vice versa*, and its mechanical action at full pressure, the other for computing the amount of its action in expansive engines.

In order to shew the limit of the possible effect from the expenditure of a given quantity of heat in evaporating water under given circumstances, the maximum gross effect of unity of weight of steam, evaporated at a higher temperature, and liquefied at a lower, is computed in two examples, and compared with the heat which disappears during the action of the steam, as calculated directly. In the first example, the water is supposed to be evaporated at the pressure of four atmospheres, and condensed at that of half an atmosphere; in the second, to be evaporated at eight atmospheres, and condensed at one atmosphere.

In both these examples, the direct calculation of the heat rendered effective, agrees with the calculation from the power developed, thus verifying the methods of computation founded on the author's theory.

The heat converted, in those examples, into engine-power amounts to only about *one-sixth part* of the heat expended in evaporating the water, the remainder being carried off by the steam and liquid water which escape from the cylinder. In practice, the proportion of heat rendered effective is still smaller, and in some unexpansive engines amounts to only *one twenty-fourth part*, or even less. It is thus

shewn, that there is a waste of heat in the steam-engine, which is a necessary consequence of its nature. It can be reduced only by increasing the initial pressure of steam, and the extent of the expansive action; and to both these resources there are practical limits.

In conclusion of the present paper, the author states, that, from his equations, many additional formulæ are deducible, with respect to the specific heat of imperfect gases, to certain questions in meteorology, and to the specific heat of liquids; but from the want of sufficient experimental data, he conceives that they are not as yet capable of being usefully applied.

2. On Probable Inference. By Bishop Terrot.

The paper commenced with a suggestion, that, as the inferences of ordinary logic admitted no premises but such as were absolutely certain, and as the premises with which we have to deal in the business of life were not certain, but only probable, therefore it was highly desirable that we should have a logic, or rules for drawing inferences on the case of probable premises.

The attention of the Society was then drawn to the 15th section of the article Probabilities, in the *Encyclopædia Metropolitana*, and especially to the following passage: "It is an even chance that A is B, and the same that B is C; and therefore, 1 to 3 from these grounds only that A is C. But other considerations of themselves give an even chance that A is C. What is the resulting degree of evidence that A is C?" To which query the answer in the *Encyclopædia* is $\frac{5}{8}$.

On this passage it was observed, in the first place, that the asserted ratio of 1 to 3, or the probability $\frac{1}{4}$ in the first syllogism, was true only on the hypothesis that A can be C only through the intervention of the middle term B. But that when such is not the case, when other ways are conceivable but totally unknown, the probability is not $\frac{1}{4}$ but $\frac{1}{2}$; these two fractions representing, the one the probability of the evidence of a complete proof that A is C, the other the probability that A is C; and it was observed, that, in practical questions, it is the latter probability alone which we have an interest in determining.

It was then shewn generally, that, if the probabilities of the premises be $\frac{p}{q}$ for the first, and $\frac{p'}{q'}$ for the second; then the probabilities of the several possible combinations are,

1. A is B and B is C, with a probability of $\frac{pp'}{qq'}$ for A is C.

2. A is B and B not C, ... $\frac{pq'-pp'}{qq'}$ for A not C.

3. A not B and B is C, ... $\frac{p'q-pp'}{qq'}$

4. A not B and B not C, ... $\frac{pp'-p'q-pq'+qq'}{qq'}$

If A can be C only through the intervention of B, then the probability of the proposition A is C is $\frac{pp'}{qq'}$. But if A may be C in other unknown ways, we must add together all the probabilities arising from all the combinations, the result of which addition was shewn to be,

$$\text{Probability } for = \frac{4\,pp' + 3\,qq' - 3\,pq'}{6\,qq' - 2\,pq'}$$

$$\text{Probability } against = \frac{3\,qq' - 4\,pp' + pq'}{6\,qq' - 2\,pq'}$$

Whence it was inferred, that if $q' = 2\,p'$, or if the second premise have a probability of $\frac{1}{2}$, each of these fractions becomes $\frac{1}{2}$, or the probability that A is C becomes $\frac{1}{2}$.

It was then shewn that a weak argument, that is to say, one affording a probability of less than $\frac{1}{2}$, diminishes instead of increasing the probability arising from any previous argument or evidence; and it was proved, that even if we take $\frac{1}{4}$ for the probability arising from the first argument, the probability arising from both conjointly was not $\frac{5}{8}$ but $\frac{3}{8}$.

The general conclusions of the paper are as follows :—

1. When the premises, which, if certain, would involve the certainty of the conclusion, are not certain, but have each a known pro-

bability, the probability of the conclusion is the product of the probabilities of the premises, in those cases only where the presence of the middle term is *necessary* for the connexion of the major and minor terms. When this is not so, then the probability of the conclusion is the product of the probabilities of the premises, *plus* the sum of the probabilities arising from the other conceivable causes of connexion.

2. In a sorites of probable premises, any premise with a probability of $\frac{1}{2}$ brings the force of the argument up to that premise inclusive to a probability of $\frac{1}{2}$.

3. When various arguments of different validities have been advanced for a proposition, or when evidence has been brought in support of argument, or argument of evidence, the resulting probability is not the *sum*, but the *average* of the several probabilities; so that a weaker argument following upon a stronger, weakens it, or rather weakens the probability produced by it.

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. II. 1850. No. 38.

Monday, 4th February 1850 (*continued*).

The Hon. LORD MURRAY, V.P., in the Chair.

3. On the Ante-Columbian Discovery of America. By Dr Elton. Communicated by Dr Traill.

The object proposed by Dr Elton, is a summary of the knowledge we possess on the discovery of the Continent of America, by several adventurous European voyagers, anterior to the time of Columbus.

This subject, which has been for almost a century and a half well known to the students of northern history, was first made known to the rest of Europe by the publication of the *Vinlandia Antiqua* of the celebrated *Torfæus* in 1705; and most of the facts given by Dr Elton are extracted from that work. *Torfæus* proved from existing Icelandic MSS., that America was discovered, and even attempted to be colonized, by his enterprising countrymen, in the end of the tenth and beginning of the eleventh century; and the descriptions transmitted to us prove that they landed on what are now Newfoundland, Nova Scotia, Massachusetts, and Rhode Island.

The first adventurer was *Leif*, the son of *Eirik the Red*, who, in A.D. 995, when attempting to pay a visit to his father, the colonizer of Greenland, was driven by stress of weather to the coast of Newfoundland, which he named *Helluland*, or *Rocky Land*. From that he sailed south-westward, till he arrived at a country, which from be-

ing covered with wood, he denominated *Markland*; and which, from the course and length of his voyage, is believed to be a part of Nova Scotia. Pursuing his course southwards, he reached a portion of Massachusetts, not far from Cape Cod; and coasting along this, he took up his winter quarters in a fertile country, which, from his description, is easily seen to have been about Rhode Island. This region, from the discovery of a species of wild vine found there, he termed *Vinland*. In the summer, he fitted out his vessel, and sailed to join his father in Greenland.

The fame of his discovery induced his brother *Thorwald*, in A.D. 1002, to sail for *Vinland*, intending to settle there; but in one of his excursions he encountered and was slain by a people, the Icelanders, in contempt denominated *Skrelings*, evidently Esquimaux, who then appear to have possessed the shores far to the south of their present location.

The next and most remarkable voyage to Vinland, was that of *Thorfinn Karlsefne*, which took place in A.D. 1006. He carried with him his wife, and one hundred and thirty-one followers, and domestic animals, with the intention of establishing a colony at the huts built by Leif in Rhode Island. The soil and climate were suitable, and they remained in that country till 1011, when they were attacked by a vast number of *Skrelings*, whom they repulsed; but the hostility of the natives induced him to abandon his design, and he finally settled in Iceland. *Thorfinn*, however, had a son, *Snorro*, born in America, from whom some of the most distinguished families in Iceland are lineally descended.

After this period, it appears that there were many voyages to *Vinland*, and that Iceland sent colonies thither for more than a century; for it is stated in Icelandic MSS., that *Eirik*, bishop of Greenland, went to *Vinland* in A.D. 1125, to confirm the colonists in the Christian faith.

The work of *Torfæus* also gives us a singular account of Icelandic voyages to a country, either a continent, or a vast island, lying far to the west of the British Islands, and near Vinland. It seems to have been first visited by *Are Marson* in A.D. 983, who was driven there by a great storm. He named it *Huitramannaland*, or *Land of White Men*, from the complexion of the natives, who were also Christians; and *Are* himself was then converted from the worship of Odin to the religion of Christ.

The same land was visited afterwards by *Gudleif Gudlagson*, an Icelandic trader with Ireland; who, in a voyage from Dublin to Iceland, was driven by a tempest to a far western land, where he was taken prisoner by the natives, but delivered by their chief, who turned out to be an *Icelander*. He was dismissed with presents, but forbidden to return. The natives were *white*, and seemed of European extraction, with a dialect like that of *Ireland;* and the American archæologists, with considerable reason, have considered that their *whereabout* was on some part of the new world, between the Chesapeake and Florida.

These early voyages seem to us very surprising; but they do not seem at all foreign to the habits and enterprise of the bold Icelanders of those ages; who not only traded to every part of the west of Europe, but to the Mediterranean, and explored *Baffin's Bay*, as high as *Lancaster Sound*. We have now a certain proof, that they were at least as high in it as at 72° 55′; for in 1825, a memorial stone with a Runic inscription, and the date of 1131, was found on the island of *Kingiktersoak*.

Several Runic inscriptions are said to have been found in America; but the most remarkable of these is the mass of *greywacke* on the shores of the river at *Dighton*, in the township of *Berkley*, in Massachusetts, not far from the supposed site of the settlement of *Thorfinn Karlsefne*. This has been lately carefully figured and engraved in the *Antiquitates Americanæ* of the Royal Soicety of Northern Antiquaries of Copenhagen, and repeated in *Jacob Aal's* translation of the *Chronicles of Snorre Sturleson*. Dr Elton, who has examined the original, assures us, that this engraving is a faithful transcript. On this rock, antiquaries read, amid figures supposed to represent Thorfinn, his wife and child, and his companions, the letters—*ϙrfin* and *cxxxi*, the number of his companions.

Dr Elton next adverted to the voyage of the Welsh Prince, *Madoc*, son of the greatest of the princes of North Wales *Owen Gwenedd*, about the year 1170. This voyage, though doubted by many, is fully believed in by Dr Elton, and it is noticed by Hakluyt, Purchas, Broughton, &c. Dr Elton quotes the singular story given by the Rev. Morgan Jones, chaplain to the British commander of the forces of Virginia in 1669. Jones was taken prisoner by the Tusscarora Indians, who intended to torture him in their usual way, when he began to lament his cruel fate *in Welsh*, which was understood by

the Indians, and he was suffered to depart in peace. These, Dr E. thinks, may have been descendants of *Madoc's followers;* and he seems inclined to ascribe to them also those very remarkable mounds, fortifications, and enclosures, which are found in such quantity in the valleys of the *Mississippi* and the *Ohio*. He is inclined also to trace to these Welsh adventurers, or at least to some early Europeans, the now almost extinct tribe, the *Mandans*—a people fairer and handsomer than the *Red men*,—that are now found 1800 miles above St Louis, on the Missouri, as described by Lewis and Clarke, and Catlin, the American travellers.

These, and several other circumstances, which might have been adduced, prove that Columbus cannot be regarded as the original discoverer of the New World.

The following Donations to the Library were announced:

Philosophical Transactions of the Royal Society of London, 1849. Part II. 4to.—*By the Society.*

Kongl. Vetenskaps. Akademiens Handlingar, för 1847 & 1848. 8vo.

Årsberättelser om Botaniske Arbeten och Uptäckter för 1843 & 1844. 8vo.

Årsberättelse om Framstegen i Kemi under År. 1847. 8vo.

Årsberättelse om Technologiens Framsteg. 1842, 1843, 1844, 1846. 8vo.

Öfversigt af Kongl. Vetenskaps. Akademiens Forhandlingar. 1848. 8vo.—*By the Academy.*

Monday, 18*th February* 1850.

The Right Rev. BISHOP TERROT, V.P., in the Chair.

The following Communications were read:—

1. On the Equilibrium of Elastic Solids. By James Clerk Maxwell, Esq. Communicated by the Secretary.

This paper commenced by pointing out the insufficiency of all theories of elastic solids, in which the equations do not contain two

independent constants deduced from experiments. One of these constants is common to liquids and solids, and is called the modulus of *cubical* elasticity. The other is peculiar to solids, and is here called the modulus of *linear* elasticity. The equations of Navier, Poisson, and Lamé and Clapeyron, contain only one coefficient; and Professor G. G. Stokes of Cambridge, seems to have formed the first theory of elastic solids which recognised the independence of cubical and linear elasticity, although M. Cauchy seems to have suggested a modification of the old theories, which made the ratio of linear to cubical elasticity the same for all substances. Professor Stokes has deduced the theory of elastic solids from that of the motion of fluids, and his equations are identical with those of this paper, which are deduced from the two following assumptions.

In an element of an elastic solid, acted on by three pressures at right angles to one another, as long as the compressions do not pass the limits of perfect elasticity—

1st, The sum of the pressures, in three rectangular axes, is proportional to the sum of the compressions in those axes.

2d, The difference of the pressures in two axes at right angles to one another, is proportional to the difference of the compressions in those axes.

Or, in symbols :—

$$1. \quad \left(P_1 + P_2 + P_3\right) = 3\,\mu\left(\frac{\delta x}{x} + \frac{\delta y}{y} + \frac{\delta z}{z}\right)$$

$$2. \quad \begin{cases} \left(P_1 - P_2\right) = m\left(\dfrac{\delta x}{x} - \dfrac{\delta y}{y}\right) \\ \left(P_2 - P_3\right) = m\left(\dfrac{\delta y}{y} - \dfrac{\delta z}{z}\right) \\ \left(P_3 - P_1\right) = m\left(\dfrac{\delta z}{z} - \dfrac{\delta x}{x}\right) \end{cases}$$

μ being the modulus of *cubical*, and m that of *linear* elasticity.

These equations are found to be very convenient for the solution of problems, some of which were given in the latter part of the paper.

These particular cases were—

That of an elastic hollow cylinder, the exterior surface of which was fixed, while the inferior was turned through a small angle. The action of a transparent solid thus twisted on polarized light, was calculated, and the calculation confirmed by experiment.

The second case related to the torsion of cylindric rods, and a method was given by which m may be found. The quantity $E = \frac{9\,m\,n}{m + 6\,n}$ was found by elongating, or by bending the rod used to determine m, and μ is found by the equation,

$$\mu = \frac{E\,m}{9\,m - 6\,E}.$$

The effect of pressure on the surfaces of a hollow sphere or cylinder was calculated, and the result applied to the determination of the cubical compressibility of liquids and solids.

An expression was found for the curvature of an elastic plate exposed to pressure on one side; and the state of cylinders acted on by centrifugal force and by heat was determined.

The principle of the superposition of compressions and pressures was applied to the case of a bent beam, and a formula was given to determine E from the deflection of a beam supported at both ends and loaded at the middle.

The paper concluded with a conjecture, that as the quantity ω, (which expresses the relation of the inequality of pressure in a solid to the doubly-refracting force produced) is probably a function of m; the determination of these quantities for different substances might lead to a more complete theory of double refraction, and extend our knowledge of the laws of optics.

2. Two Letters from W. E. Logan, Esq., to Earl Cathcart.

These letters were dated in August 1846 and September 1847. Earl Cathcart intended himself to have read them to the Society, but, having been prevented by his official duties from coming to Edinburgh, had sent them, to be communicated in his name.

In the first letter, the author, who had been sent to examine the geology of Canada, describes a visit which he made, on his way to Fort-William, Lake Superior, to the silver and copper mines on the south side of the lake, in the territory of the United States.

He considers the formation in which the mines occur as being older than the new red. They consist of parallel ranges of trap and conglomerate, apparently interstratified. They are well displayed at and near Copper Harbour. They are sometimes so thick as to

form mountain ranges. The conglomerate consists of trap pebbles in trap sandstone; the trap is sometimes compact, at other times amygdaloidal. The strata run in a curvilinear direction. They dip to the north, with a slope of 16° to 30°, the veins are at right angles to the strata, and run nearly north and south. The veinstones are steatite, quartz, calcspar, and zeolites. The ores are those of copper, silver, iron, and lead, the two former being productive. The two metals are chiefly native, but occur also in other forms. They are least abundant in the conglomerate, more so in the trap, most of all in the amygdaloid. They are found also in amygdules of the rock near the veins. The quantity of native copper is very great. In the Copper Falls Mine, near Eagle Harbour, on sinking a pit to 72 feet, the compact trap and amygdaloid were found to alternate six or seven times. The main vein was 18 to 20 inches thick. In the shaft, about 40 feet down, a mass of native copper was found, of which the dimensions were estimated by the author, *in situ*, to indicate a weight of about 30 tons. It had not yet been found possible to remove it. A diagram of its position was given.

From other shafts in the vicinity, much copper had been extracted, but with prodigious difficulty, from the tough metal binding the rock firmly together, and rendering blasting useless. The author saw, on the surface, besides many pieces of 25 lb., seven masses, varying from 75 to 1200 lb., and weighing in all 4000 lb., or nearly 2 tons. Native silver is found with the copper, and a mass of 3¼ lb. had been obtained. The author saw one of 1¼ lb. The author is of opinion that the very richness of this mine in native copper may render it unproductive, from the difficulty and expense of working it.

In the Cliff Mine, on Eagle River, there is the same abundance of copper, with more silver. Part of the rock was said to yield 7 per cent. of silver; but subsequently was found hardly to pay for its extraction. The author saw here a mass of silver of 3½ lb. Every vein in the trap seen by the author contained native copper. At the Eagle River Mine, silver is found in large masses, one of which weighed 7 lb. 2 oz.

On the Canada side, as far as the author had then examined it, from Fort-William to Pigeon River, indurated shale prevails, overlaid by greenstone, with patches of porphyry. Many trap-dikes are seen, forming long narrow promontories and deep harbours on the

shore of the lake. A system of veins occurs at right angles to the dikes, containing barytes, in addition to the veinstones formerly mentioned. The veins vary from 6 inches to 20 feet. In one of them 14 or 15 feet thick, well seen on Spar Island, gray sulphuret of copper occurs in considerable abundance, especially in a part of the vein, nearly 5 feet thick. Native silver also occurs in small quantity. There are also veins parallel to the dikes which contain ores of copper. But the author could not form a decided opinion in 1846 of the value of these mines.

In the second letter, he gives some of the results of an examination of the eastern townships of Canada, from Lake Champlain and the Richelieu to the Chaudiere. He observed facts proving the green mountains of Vermont to be more recent than the Loraine shales, or Hudson River group. Of the upper rocks, the most interesting was a band of serpentine, 150 to 400 yards broad, which the author traced continuously for 150 miles, and which probably extends as far again. It has occasionally rich beds of magnetic iron and of chromate of iron; of the latter, a boulder was found, weighing 6 cwt. The gravel on the Chaudiere, besides these minerals, contains titaniferous iron and gold. The author expects to find platinum, as the gravel in all other respects resembles that of the Russian auriferous district. The auriferous sand is found on the tributaries of the Chaudiere. It will probably pay for extraction. 60 bushels washed by Mr Derby, yielded 18 dwt. 8 gr., or about 1s. 6d. worth per bushel. The gold has not yet been found *in situ*.

3. Notes on Practical Chemical subjects. By Alexander Kemp, Esq. Communicated by Professor Gregory.

1. *On the Purification of Sulphuric Acid.*

The author, after describing the different methods, recommended for purifying sulphuric acid from nitric acid, namely, boiling with a little sugar, and heating with sulphate of ammonia, both of which had proved troublesome and imperfect, stated, that after trying various plans, the only one which he found to answer well, was the action of sulphurous acid on the oil of vitriol, after diluting it to the sp. gr. of 1·715, or lower. He adds one volume of water to three of the oil of vitriol, passes sulphurous acid gas through the hot liquid till it is in excess, and then boils off the excess of sulphurous acid; or, still better, three volumes of oil of vitriol are added to or diluted with, one of a saturated solution of sulphurous acid in pure water,

and boiled. The acid is thus so perfectly purified from nitric acid, that when used for making hydrochloric acid, it yields a product quite colourless, which was not the case with the oil of vitriol purified by any other process.

If the oil of vitriol be diluted with one-half its volume of sulphurous acid solution (or of water, previously to passing the gas through it), the sulphate of lead is also totally separated, and the clear liquid, decanted from the precipitate, and boiled down to sp. gr. 1·845, is colourless, and almost chemically pure.

2. *On the Preparation of Pure Hydrochloric Acid.*

Professor Gregory, in his process for preparing hydrochloric acid, by heating 1 equivalent of sea-salt with 2 equivalents of sulphuric acid of sp. gr. 1·650, directs the use of patent salt, to avoid the presence of iron in the product.

The author observed, that there is always a certain quantity of iron in the residue, even when patent salt is used; but that none passes over with the hydrochloric acid. He then added iron and peroxide of iron in considerable quantity to the materials. Still no iron passed over. It would appear, that when iron had been observed by Professor Gregory in minute quantity, in the hydrochloric acid made by his process, from common salt, it had either passed over at the very end of the process, when the temperature rose very high, although the author could not, in his own experiments, observe this, or, more probably, had been present in the test employed. It is probable that, even when much iron is present in the materials, the presence of the excess of sulphuric acid, and also the low temperature at which the process goes on, prevent the formation of the chloride of iron.

The author's observations enable us to prepare, from the commonest and cheapest salt, perfectly pure and colourless hydrochloric acid, and thus still further to reduce the price of this reagent, so essential to the chemist.

Professor Gregory also briefly stated some observations by Mr Kemp and himself, on the purification of chloroform, which he was to describe more fully at a subsequent meeting.

Dr Stark

Was balloted for, and duly and unanimously re-elected a Fellow of the Society.

Monday, 4th March 1850.

General Sir THOMAS MAKDOUGALL BRISBANE, Bart., President, in the Chair.

The following Communications were read :—

1. Analysis of the Anthracite of the Calton Hill, Edinburgh. By Dr A. Voelcker. Communicated by Dr George Wilson.

Dr Voelcker observed, in the introduction to his paper, that we are in possession of analyses of anthracite from different localities, from which it appears that different specimens vary much in the proportion, but very little in the nature, of their ingredients. All samples of anthracite which have been analysed, have been found to contain carbon, oxygen, hydrogen, and nitrogen, as well as more or less inorganic matter. Sulphur also has generally been found, at least when sought for; but it does not appear in many recorded analyses.

The anthracite employed in the following analyses was furnished by Dr Fleming, and first carefully dried, after being finely powdered, by exposing it for several hours to a current of dry air, at a temperature of 230° F. The carbon and hydrogen were ascertained, by burning from three to four grains of the mineral with a mixture of oxide of copper and oxide of lead, which is much less hygroscopic than the pure oxide of copper. A mixture of this oxide and chlorate of potass was also placed in the shut end of the combustion-tube, from which oxygen was evolved in the usual way towards the close of the process.

The nitrogen was determined by Will and Varentrapp's method. The sulphur was ascertained by projecting into a red-hot platina crucible, in successive small quantities, a mixture of anthracite in powder, with nitrate of potass and carbonate of soda, and afterwards maintaining the product of deflagration at a high temperature for some time. The resulting fused mass which was perfectly white, was dissolved in water, super-saturated with hydrochloric acid, and precipitated by chloride of barium.

About ten grains of the mineral were employed in the determination of the amount of ash. It was red, and contained oxide of iron.

The following are the results of the analysis :—

Carbon, . . .	91·23
Hydrogen, . .	2·91
Nitrogen, . .	0·59
Oxygen, . . .	1·26
Sulphur, . . .	2·96
Ash, . . .	1·05
	100·00

The most remarkable peculiarity of the Calton Hill anthracite, as appears from the results given above, is the large proportion of sulphur it contains, amounting to nearly 3 per cent. Sulphur has been supposed to occur in the different varieties of coal in combination with iron, as pyrites, but the trace of that metal present in the Calton Hill anthracite is so small, that the sulphur must have been combined with the organic constituents of the mineral.

Note on the Crystallisation of Carbon, and the possible derivation of the Diamond from Anthracite and Graphite. By Dr George Wilson.

The author stated that the object of his communication was, to suggest the possibility of anthracite as well as graphite being substances from which the diamond is developed. After referring to previous theories, as all assuming that carbon must have been fluid or semifluid, before it crystallised, he stated that his hypothesis contemplated the possibility of graphite, as well as amorphous carbon, and its solid combinations, such as anthracite, undergoing crystallisation into the diamond, without losing their solidity during the change. He thought anthracite more likely than most substances to yield the diamond, for the following reasons:—

Firstly, As it occurs in nature, in many localities, it is found passing by insensible gradations, on the one hand, into common coal, on the other, into graphite; so that it may be regarded as representing the transition-state from fossilised vegetable matter to pure carbon, and as tending, under the influence of certain agencies, to change ultimately into the latter.

Secondly, The chief element of anthracite is carbon, of which it frequently contains 91, and sometimes 95 per cent.

Thirdly, Its other ingredients (with the exception of the ash, which is often under one per cent.), namely, hydrogen, oxygen, nitrogen, and sulphur, form volatile compounds with each other, and with

the oxygen of the air, so that by a slow process of spontaneous decomposition, and gradual oxidation or eremacausis, all the constituents of the anthracite, except the excess of carbon and the ash, may be evolved, and carbon left free.

The separation, in this way, of the non-carbonaceous elements of the anthracite would be attended with a disturbance of the molecular equilibrium of the mineral, which would necessitate a new arrangement of its particles, and might determine the induction of the crystalline condition characteristic of the diamond. During this process, the inorganic saline matter, or ash, would either be excluded by the power crystallising bodies are known to possess of expelling heterogeneous matter, or be included in the crystallising carbon. Either view would consist with observation ; for whilst some diamonds appear to be pure carbon, many leave a slight ash when burned in oxygen.

The author further observed, that whether anthracite will crystallise into graphite or diamond, will be determined chiefly by the temperature at which crystallisation occurs, and the rapidity with which it proceeds. Graphite represents the condition of most stable equilibrium, which the crystalline molecules of carbon assume, when aggregated rapidly at a high temperature. The diamond, on the other hand, has all the characters of a crystal which has formed very slowly at a lower temperature, and it will not change into graphite, unless it be suddenly exposed to an intense heat. Whenever, therefore, carbon crystallises very slowly at ordinary temperatures, it may be expected to become the diamond rather than graphite, and the latter must be considered as a substance which, when not maintained at an elevated temperature, is liable to re-arrange its particles in the condition of more stable equilibrium characteristic of the diamond. The author, at the same time, observed, that he did not seek to affirm that all diamonds had been produced from anthracite or graphite, but thought it, on the other hand, probable, that, like other crystallisable substances, carbon might be crystallised in various ways.

2. On the Proportion of Fluoride of Calcium present in the Baltic. By Professor Forchammer of Copenhagen. With some preliminary Remarks on the presence of Fluorine in different ocean waters. By Dr George Wilson.

Dr Wilson reminded the Society that he had announced to them in 1846 the occurrence of fluorine in the water of the Frith of

Forth, and mentioned, that, in the preceding summer, he had found it in deposits obtained during the evaporation of sea-water from the Frith of Clyde, and the German Ocean. Professor Forchammer had made similar observations on the Baltic, and had furnished Dr Wilson with the account of them which follows. Before reading this, he wished to add, that he had recently examined incrustations from the boiler of a steam-vessel sailing between Liverpool and Dublin, and similar deposits from the Canada Transatlantic steamer, and H.M. war-steamer Sidon, which had been three years on the Mediterranean station. The different crusts were, without preliminary treatment, except reduction to powder, heated with oil of vitriol, and were found to yield an acid vapour which etched glass. Specimens of glass, in illustration, were shewn to the Society. From these observations, Dr Wilson inferred the presence of fluorine in the Friths of Forth and Clyde, in the German Ocean, the Irish Sea, the Atlantic, and the Mediterranean. He then proceeded to read Professor Forchammer's communication, which follows. It is dated, Copenhagen, 20th December 1849.

Abstract of a Paper by Professor Forchammer, on the rarer Substances which occur in Sea-water.

Fluorine and Phosphoric Acid.

100 lb. of sea-water, as it occurs in the Sound, near Copenhagen, of which the average quantity of salts is between 2 and $2\frac{1}{2}$ per cent., was evaporated. When the solution was so concentrated that it began to deposit salt, it was, without filtering it, mixed with an excess of ammonia, and the precipitate collected and washed. The whole precipitate which contains carbonate, sulphate, and phosphate of lime, fluoride of calcium, silica, and magnesia, was redissolved in muriatic acid, which left the greater part of silica undissolved; the solution was mixed with muriate of ammonia, and a second time precipitated by an excess of ammonia. This precipitate from 100 lb. of sea-water weighed 3·104 grains, and consisted of phosphate of lime and fluoride of calcium. It was divided into two equal parts, of which the one was in a platina crucible, mixed with concentrated sulphuric acid, and allowed to act on a slip of glass, covered with wax, in which some words were scratched with a copper needle. The glass was most decidedly etched, but the words appeared more clear

and legible if breathed upon. The second half part was likewise mixed with sulphuric acid, but in a bent tube, and distilled into a small vessel which contained a weak solution of ammonia. The tube was etched, and the vessel contained precipitated silica. It was thus completely proved that sea-water contains fluoride of calcium, but the quantity in 100 lb. sea-water from the Sound at Copenhagen can hardly exceed one-half of a grain, or since the proportion of the different salts varies very little in sea-water, it will be about one grain in 100 lb. of water of the ocean, which contains between 3·5 and 4 per cent. of salts.

All the residuums from the trials to find fluorine were dissolved in muriatic acid, and thrown down by an excess of ammonia. The precipitate, washed, dried, and heated, was mixed with potassium in a glass tube [and heated], until the excess of potassium was driven off. The lower part of the tube was cut off and thrown into water, where it for hours continued to give out small bubbles, distinguished by the peculiar smell of phosphuretted hydrogen, although they did not inflame by themselves. Thus the existence of phosphoric acid was likewise proved, although I could not try the delicate test for phosphoric acid which we owe to Mr Svanberg, it not being known at the time when I made my experiments.

In all the different species of corals which I analysed, I likewise found fluorine.

In a postscript to the preceding communication, Professor Forchammer states, that the paper, of which it is an abstract, "contains experiments on many other substances, contained in minute quantities, in sea-water; for instance, manganese, ammonia, baryta, or strontia, besides iron and silica, which occur in proportionally large quantities."—G. W.

3. On an Application of the Laws of Numerical Harmonic Ratio to Forms generally, and particularly to that of the Human Figure. By D. R. Hay, Esq.

The author stated in some prefatory remarks, that a belief in the operation of the laws of numerical harmonic ratio in the constitution of beautiful forms had long existed, although those laws had not been systematised so as to render them applicable in the formative arts. In proof of this, Mr Hay quoted a correspondence upon the subject

of harmonic ratio, between Sir John Harrington and Sir Isaac Newton, in which the latter expresses his belief in such laws in the following words: "I am inclined to believe some general laws of the Creator prevailed with respect to the agreeable or unpleasing affections of all our senses; at least the supposition does not derogate from the power or wisdom of God, and seems highly consonant to the simplicity of the macrocosm in general." The belief of this great philosopher, the author trusted, would form some apology to men of science for the repeated attempts he has made to establish the fact. These attempts he had hitherto made with reference to architecture, to ornamental design, and latterly to the human head and countenance; but on the present occasion he intended to shew the operation of these laws in constituting the symmetrical beauty of the entire human figure.

He next proceeded to point out the remarkable similarity that exists in the physical constitution of the organs of hearing and seeing, and the manner in which external nature affects the sensorium through these organs; shewing the difference between noises and musical sounds in the one case, and irregular and regular forms in the other. He explained that each musical sound was produced by a number of equal and regular impulses made upon the air, the frequency of which determining the pitch of the sound, their violence its loudness; and the nature of the material by which the impulses were made its quality or tone. In like manner, he shewed that the effect upon the optic nerve produced by external objects is simply that of the action of light, and amenable to the same laws. Variety of form being analogous to variety of pitch; variety of size to that of intensity or loudness, and variety of colour to that of quality or tone.

Mr Hay next explained the nature of the harmonics of sound, which result from the spontaneous division of the string of a monochord by the formation of nodes during its vibratory motion. He then shewed how the harmonics of form could be evolved from the quadrant of a circle by the following process:—

From a horizontal line MR (figure 1, of the annexed Plate), he produced two parallel vertical lines ML and RS indefinitely, and with a radius MR described, from the centre M, the quadrant OR. From O he divided the arc of the quadrant into parts of $\frac{1}{8}$, $\frac{1}{7}$, $\frac{1}{6}$, $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{3}$, and $\frac{1}{2}$. From the centre M, and through these divisions, he produced the lines MN, MP, MQ, MT, MU, MV, and MS, until

they met RS, forming the right-angled triangles MPR, MQR, MTR, MUR, MVR, and MSR. He then shewed, that as the angles at the vertex of each of these triangles, contained respectively 45°, 30°, 22° 30′, 18°, 15°, 12° 51′ 26″, 11° 15′, they related to the right angle, as the harmonics of sound, expressed by the signs c, g, $\bar{c}$, $\bar{e}$, $\bar{g}$, $\bar{b}\flat$, and $\bar{\bar{c}}$, relate to the fundamental note C, produced by the string of the monochord. These triangles he combined in the following manner upon a line AB (figure 2, of the annexed Plate), which he said might be of any given length according to the size of the figure to be formed. From B at an angle of 11° 15′ with AB he drew the line Bg indefinitely, and from A at an angle of 15° with AB the line Ar, also indefinitely, and cutting Bg in K. Through K he drew KL at right angles with AB, forming the triangles ALK and KLB. Through K he drew the line pO parallel to AB. From A at an angle of 12° 51′ 26″ with AB he drew AV, cutting pO in M, and drew MN at right angles with AB, forming the triangle AMN. From A at an angle of 18° with AB, he drew Au, cutting pO in H, and drew HI at right angles with AB, forming the triangle AHI. From A at an angle of 22° 30′ with AB, he drew At, cutting pO in F, and drew FG at right angles with AB, forming the triangle AFG. From A at an angle of 30° with AB he drew As, cutting pO in C, and drew CD at right angles with AB, forming the triangle ACD. From C at an angle of 45° with AB and CD he drew CE, forming the triangle CDE. Thus, he observed, were the triangles arising from the harmonic angles constructed upon AB in the same relative proportions to each other, that they were when formed upon the line RS, figure 1. Upon the other side of AB he constructed similar triangles forming the equilateral triangle ACC; the right-angled isosceles triangle ECC, and the acute-angled isosceles triangles AFF, AHH, AKK, AMM, and BKK. Within this diagram he shewed that the human skeleton could be formed in the most perfect proportions, determining, at the same time, the centres of all the various motions of the joints; and also that the symmetrical beauty of the external form, whether in a front or profile view, was governed by these angles; thus endeavouring to prove that an application of the laws of numerical harmonic ratio in the practice of the sculptor and painter would give these imitative arts a more scientific character than they at present possess, and, so far from retarding the efforts of genius, would rather tend to facilitate and assist them.

FIGURE 1.

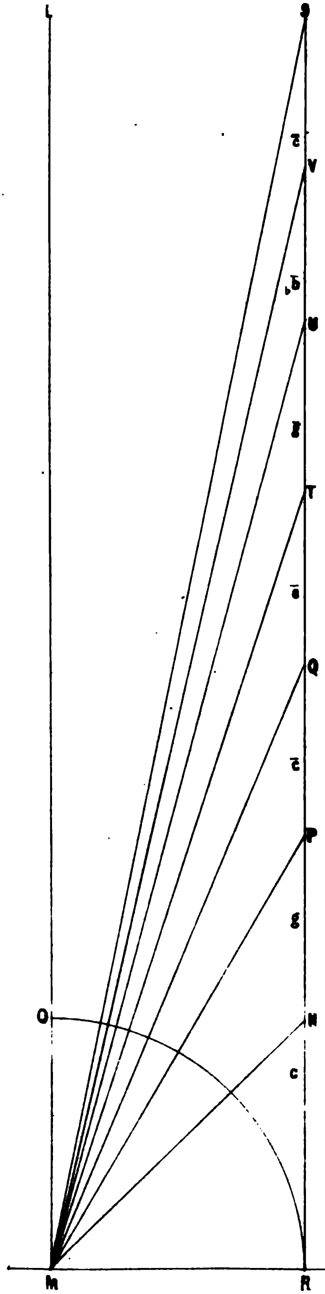
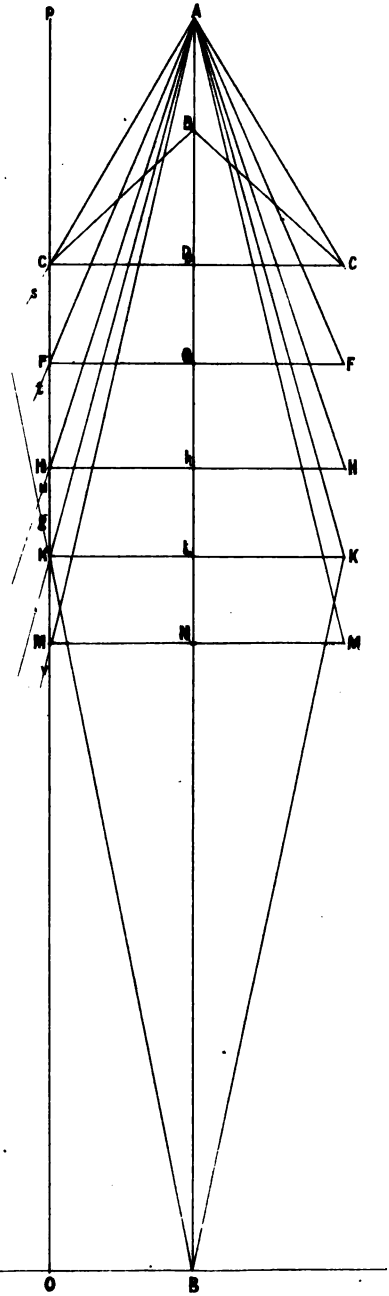


FIGURE 2.



F. Schenck, Lith. Edinr

PROCEEDINGS

OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. II. 1850. No. 39.

Monday, 4th March 1850 (*continued*).

The following Gentlemen were duly elected Ordinary Fellows:—

Lieut. W. Driscoll Gosset, Royal Engineers.
Dr William Sellar, Pres. R.C.P.E.

The following Donations to the Library were announced at the Meeting of 18th February:—

The London University Calendar. 1850. 12mo.—*By the Publishers.*

The American Journal of Science and Arts. Conducted by Professors Silliman and Dana. Vol. IX., No. 25. 8vo.—*By the Editors.*

Mémoires de l'Académie Impériale des Sciences de St Pétersbourg. Sixième Série. Sciences Mathématiques, Physiques et Naturelles. Tome VIIIme, 2me partie. Sciences Naturelles. Livraisons 3me, 5me, et 6me. 4to.

Mémoires présentés à l'Académie Impériale des Sciences de St Pétersbourg, par divers Savants et lus dans ses Assemblées. Tome VIme. Livraisons 2de et 3 me. 4to.—*By the Academy.*

Messungen zur Bestimmung des Höhenunterschiedes zurischen dem Schwarzen und Caspischen Meere, von G. Fuss, Sawitsch und Sabler. 4to.—*By the Authors.*

Rapport fait à l'Académie Impériale des Sciences de St Pétersbourg,

par W. Struve. Sur une Mission Scientifique dont il fut chargé en 1847. 4to.—*By the Author.*

W. Struve sur la Delatation de la Glace d'après les expériences faites en 1845 et 1846 à l'Observatoire Central de Poulkova, par MM. Schumacher, Pohrt, et Moritz. 4to.—*By the Authors.*

Über Prof. Mädlers Untersuchungen über die Eigenen Beweyungen der Fixsterne, von C. A. F. Peters, Dr. 4to.—*By the Author.*

P. H. Fuss Nachricht über eine Sammlung Unedirter Handschriften Leonhard Eulers, und über die Begonnene gesammtausgabe seiner Ueineren schriften. 8vo.—*By the Author.*

Über die Genanig-keit der in Lalandes Catalog, publicirt von der *British Association*, enthaltenen Sternörter, von Dr Lindhagen. 8vo.—*By the Author.*

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft bei ihrer Versammlung zu Slothurn. 1848. 8vo.—*By the Society.*

Mittheilungen der Naturforschenden Gesellschaft in Bern, aus dem Jahre, 1848–9. Nos. 135–161. 8vo.—*By the Society.*

The following Donations to the Library were announced at the Meeting of 4th March :—

Transactions of the Cambridge Philosophical Society. Vol. VIII. 4to.—*By the Society.*

The Astronom. Jour. Vol. I., Nos. 2, 3, & 4. 4to.—*By the Editor.*

Proceedings of the R. Ast. Soc. Vol. X., No. 3. 8vo.—*By the Society.*

Proceedings of the Linnæan Society of London. Nos. 30–40. 8vo.

Charter and Bye-Laws of the Linnæan Society. 1848. 8vo.

List of the Linnæan Society. 1849. 4to.—*By the Society.*

Journal of Agriculture and Transactions of the Highland and Agricultural Soc. of Scotland. No. 28, N. S. 8vo.—*By the Society.*

Annales des Sciences Physiques et Naturelles, d'Agriculture et d'Industrie, publiées par la Société Nationale d'Agriculture, &c., de Lyon. Tom. II. 1848. 8vo.—*By the Society.*

A Collection of Maritime Charts, with corresponding Descriptions. —*By the French Government.*

Monday, 18*th March* 1850.

The Right Rev. BISHOP TERROT, V.P., in the Chair.

The following Communications were read:—

1. Note regarding the American Electric-Observing Clocks. By Professor Piazzi Smyth.

The object of this communication was chiefly to exhibit a specimen of the register of the electric chronograph, wherein the second's beats of two clocks were marked side by side, one going nearly to sidereal time, and the other to solar; and the length of a second's interval on the paper was so great, and the accuracy of the punctuation such, that the minute acceleration of the one clock on the other could be registered almost from second to second.

The electric register can be applied with ease to any clock, and at any distance from the recording apparatus; and two or more clocks, or they may be simple pendulums, can be made to register their vibrations on the same slip of paper.

The author pointed out how this method might be made available for determining the density of the earth, by observations on the shores of the Bay of Fundy, during the rise and fall of the enormous tides which occur there. He likewise mentioned several purposes to which Lieutenant Maury, U. S. N., proposed to apply the electric chronograph; amongst others, to determining the height of mountains, as he thought that the accuracy capable of being attained in determining the time of vibration of a pendulum in this manner, was so extreme, that the method might be safely applied to such problems.

2. Account of a Remarkable Meteor, seen 19th December, 1849. By Professor J. D. Forbes.

"On the evening of the 19th December 1849, whilst walking near the southern part of Edinburgh, about fifteen minutes past five. Greenwich time (as I afterwards estimated), I observed a meteor, fully brighter than Venus at her average brilliancy, moving from W. towards N., parallel to the horizon, elevated 15° above it, and followed by a distinct luminous train. This angle was subsequently

taken by estimation by daylight, with the aid of a theodolite; and the compass-bearing of the meteor, when first seen, ascertained in the same way, must have been 47° W. of N. When it bore 29° E. of magnetic north, it was observed to have divided into two, the one part following the other at some distance; and I soon after lost sight of it in the obscurity of the smoke of the town. When it split, its altitude was estimated at 6°. It thus described an arc of no less than 76°, in doing which it occupied, as I roughly estimated, about 15 seconds, or possibly more.

"Having sent a short notice of the appearance of the meteor to the Courant newspaper, I received from many quarters accounts of its having been seen under circumstances remarkably similar to those just described. I believe that nearly forty communications on the subject have reached me from places included between Longford, in the centre of Ireland, to near Bervie, in Kincardineshire, a distance of above 300 miles, in a direction nearly NE. and SW., whilst in a perpendicular direction, or from NW. to SE, the range of observation has been comparatively small; for I have received no information from beyond Renfrew, in the one direction, and Durham in the other; being about 140 miles distant in a straight line. The meteor was seen at Longford, in Ireland, 74 miles west of Dublin, but not in Dublin itself. It was seen at Belfast, between Carlisle and Gretna at Stewarton in Ayrshire, at Johnstone, at Paisley, Renfrew, and by many persons in Glasgow and the neighbourhood. It was also generally seen in Edinburgh, in East Lothian, near Melrose, and at Durham, as already mentioned. Further north, I have received accounts from Crail, St Andrews, Dundee, Perth, and Johnshaven to the north of Montrose.

"The greater number of these communications concur in estimating the direction of the motion of the meteor to have been from SW. to NE., although, as might be expected, they vary excessively as to its distance and magnitude; being described by some persons as only 50 or 100 yards off, and as large as the moon; by others, as a ball of 9 inches in diameter, or the size of a large egg. One person only professes to have heard a sound. The time during which it was seen was variously estimated. At Longford, by Mr Curtis, 20 sec.; at Glasgow, by Mr Stevenson, at 20 sec.; at Johnstone, by Mr Cunningham, 15 sec.; at Perth, 15 or 20 sec.; at Durham, by Mr Carrington, 30 sec.; at St Andrews, 15 seconds according to one

observer, and 18 to 21 seconds according to another ; at Johnshaven, $\frac{3}{4}$ths of a minute. The hour of the appearance of the meteor, in most of the descriptions, is stated at between 5h. 10m., and 5h. 16m.

"The arc of the horizon which it was seen to traverse depended, of course, on the point where the meteor first caught the observer's eye. At Granton, it was traced by Professor Kelland through 125° of azimuth ; at Perth, 130 ; at St Andrew's, 74° ; at Edinburgh, 76° ; at Durham, 65° ; at Glasgow, from 60° to 70°. The division of the head or nucleus into several parts, and, first of all (in most cases), into *two*, has been noticed with remarkably slight variation ; consequently, the explosion of the meteor marks a well-determined point in its path. The separation was specially noticed at Edinburgh, Granton, Glasgow, Renfrew, Melrose, Haddington, Johnshaven, Perth, Durham, St Andrews.

"In a majority of cases a luminous train was observed ; and I am confident, that the existence of this train, which has been estimated at from 2° to 3° long, cannot be questioned. Dr Adamson, however, especially remarked that no train was to be seen at St Andrews.

"On revising the whole accounts, it does not appear that any of them can be relied upon, for ascertaining the position of the meteor in space, except the observations of Mr Carrington of the Durham observatory ; of Professor Kelland, Mr Stirling, and myself, at Edinburgh ; of Dr Adamson and another observer, communicated by Professor Fischer of St Andrew's ; of a young gentleman at Perth, communicated by Thomas Miller, Esq., Rector of the Perth Academy ; and of A. D. Stevenson, Esq., and W. Gourlie, Esq., junior, at Glasgow. My inquiries were chiefly directed to the two following points: *first*, the angular elevation of the meteor in the NW. quarter of the heavens, where it is admitted by all that its path appeared almost horizontal ; *secondly*, to the bearing of the meteor at the instant of explosion.

"At Durham, Mr Carrington saw the meteor first when the bearing was true NW., the altitude (by theodolite) was then 10°, or not exceeding 11°; when it burst, it was due N. (true), and continued to move 10° or 12° further before it disappeared. Professor Chevallier, who obligingly communicated these results, states that the meteor appeared rather to rise as it approached the north, but with a doubt. This supposition, however, appears inadmissable, from the unanimity of the other accounts.

"At Granton, near Edinburgh, Professor Kelland caught sight of the meteor a little to the N. of the moon, and several diameters below it. This corresponds, by after estimation with a theodolite, to 75° W. of magnetic N., and an altitude of 12°. Professor Kelland thinks that it rather rose afterwards. It split into two at 20° E. of magnetic N., having then an altitude of only 5°; it continued for a considerable time bright, then began to fade, as if by the effect of distance, and also to separate into several parts: it was finally lost sight of 50° E. of magnetic N. (this bearing is well ascertained), with an altitude estimated at only half a degree. The position and circumstances of these observations, made at an elevated station above the Frith of Forth, were eminently favourable.

"Mr J. Stirling, civil engineer, looking up North Hanover Street, Edinburgh, saw the meteor separate into two parts; the bearing he afterwards estimated at 25° E. of magnetic N. (the probable error not exceeding 1°), and the altitude at 8° 30′, certainly not exceeding 9°.

"I think we may conclude, that at Edinburgh the meteor attained a maximum elevation of 15° (that mentioned in the commencement of this paper), since it no doubt rose after Professor Kelland first saw it to the S. of the true W., with an altitude of only 12°. The course of the meteor was evidently such as to be nearest the spectator when in the true NW. or WNW.

"The place of the meteor when it burst stands thus:—

Kelland,	N. 20° E. (mag.)	Alt. 5°.
Stirling,	N. 25° E.	Alt. 8° 30′.
Forbes,	N. 29° E.	Alt. 6°.

"The average is almost 25° E. of N., or about 1° W. of the true meridian, the variation being nearly 26°. The mean of the three observations of altitude would be 6° 30′; but admitting Mr Stirling's to be entitled to the greatest confidence, we may suppose it 7°, or possibly a little more.

"At St Andrews, the meteor was seen by Dr Adamson, when riding in a northerly direction, on the Largo road. Professor Fischer was so kind as to accompany him afterwards to the spot, and to reduce his observations with all the accuracy of which they were capable. It was first noticed when bearing 8½° W. of magnetic N., and disappeared at 42½° E. of N.; the altitude was conjecturally

stated as between 14° and $18\frac{1}{2}$°, and it appeared to move horizontally, but rather declining towards the N.

"After describing three-fourths of its course, it split into two parts, which went on close together for a little, then broke into four or five, became dull red, and rapidly disappeared; the separate pieces travelling on together until the last.

"Another intelligent observer near St Andrews, whose evidence was taken by Mr Fischer, first saw the meteor $29\frac{3}{4}$° W. of magnetic N., and estimated the point where the meteor burst at 44° E. of N.; but this last number coincides so closely with Dr Adamson's estimate of the point of final disappearance, that it is perhaps allowable to suppose, that this second observer had mixed up these two events in his description. Dr Adamson's statement, that one-fourth of the arc which he saw was described after the meteor had split, would give an azimuth at that moment of almost 30° E. of N. magnetic, or 4° E. of N. true, as Mr Fischer determined the magnetic declination to be about 25° 46′. The altitude of the meteor, as seen by this observer, appears not to have exceeded 15° (the same as at Edinburgh); which number we shall therefore adopt.

"At Perth, the passage of the meteor was seen from the North Inch, by a young gentleman of intelligence, whose observations were reduced to numbers by Mr Miller, Rector of the Perth Academy, who was so good as to accompany him to the spot, and take the angles with a theodolite. Its bearing, when first seen, was 46° S. of W. true; its angular altitude was at that time only 3° 30′. This is by far the most southern azimuth which has been observed. Its bearing, when it disappeared, was 6° W. of N., but it was then lost in a cloud. If I understand right, it had, by this time, separated into fragments. Its apparent altitude, in the middle of its course, was about 17° 30′. These observations, extending over an arc of 130°, taken along with Professor Kelland's, clearly demonstrate that the meteor appeared with a very low altitude in the SW. quarter of the heavens, and disappeared in a similar way in the NNE., attaining its greatest elevation about WNW. (true.)

"At Glasgow the meteor was very generally and well seen. Mr William Gourlie junior saw it move from SW. to NNE., over an arc of 60° or 70°, and divide into two, when it bore 40° E. of magnetic N. He estimates its greatest elevation at 30°, and that it

decreased to between 15° and 17°, or even less, at the time of its separation. He adds, that he is not much accustomed to such observations. Mr A. D. Stevenson, living in South Portland Street, Glasgow, saw the meteor moving along, at a height just sufficient to clear the chimney-tops, on the west side of the street, an elevation which he afterwards estimated, as he states, with considerable accuracy at 28°. I have received farther and more minute accounts of the appearance of the meteor from Mr Stevenson, who has been most kind and intelligent in his communications; and my friend Mr James Peddie has verified the accuracy of Mr Stevenson's observations beyond the possibility of mistake. It appears that the meteor passed quite clear of a stack of chimneys on the opposite side of the street, which would give it a well-defined minimum altitude of 25° 41′; but Mr Stevenson is of opinion that it rose more than 2° higher, or to not less than 28° (perhaps even to 28° 21′); when it was highest, its bearing was 52½° W. of N. (magnetic), and it disappeared from his view when it bore 40° 27′ E. of magnetic N. *It was then decidedly single.* Now, this bearing coincides with that at which Mr Gourlie observed it to become *double;* and, consequently, the limit towards the N. of this event is severely defined.

"The following Table contains the most definite of these observations, and the azimuths are all reduced to the true meridian :—

	Greatest Altitude.	True Azimuth when first seen.	True Azimuth of disappearance.	Arc observed.	True Azimuth of first explosion.	Altitude at first explosion.
Durham,	10° 30′	N. 45° W.	N. 12° E.	57°	N.	
Edinburgh,	15°	W. 11° S.	N. 24° E.	125°	N. 1° W.	7°
St Andrews,	15°	N. 55° W.	N. 16° E.	71°	N. 4° E.	
Perth, .	17° 30′	W. 47° S.	N. 7° W. (in a cloud)	130°	?	
Glasgow,	28°			100°?	N. 14° E.	15°

Remarks on the Observations.

"1. On the whole, these observations are not consistent, and cannot (I conceive) be cleared up without additional and accurate ones, which it may now be too late to procure. The central group of stations, Edinburgh, Perth, and St Andrews, are sufficiently accordant, and indicate that the path of the meteor must have been nearly parallel to a line passing through the first and last of those places, or in a direction N. 27° E. (true); which accords well with the observations at most of the individual stations, and particularly with the *vanishing direction* in Professor Kelland's remarkable observation at Granton.

"2. The Durham observation is compatible with the above-mentioned group within the limits of error. By the combination of Durham and Edinburgh (the base line perpendicular to the assumed direction of the meteor's motion being 95 miles), I calculated that the meteor passed vertically nearly over the Island of St Kilda, with an absolute elevation of about 88 miles. But this solution seems absolutely excluded by observations at Glasgow which admit of no question, and which I have spared no pains in verifying. Had the position of the meteor been such as I have first assumed, it could not possibly have been seen over even the roofs of the houses from the station occupied by Mr Stevenson, much less over the chimney-tops. The bearing, at the moment of explosion at Glasgow, also singularly enough corroborates sufficiently well the comparatively small elevation (about 20 miles above the earth) which the combination of Edinburgh and Glasgow gives; and this bearing we have seen to have been also accurately defined by the physical obstacles bounding the observer's view; it would have given a parallax of 15°, subtended by the perpendicular on the meteor's path, referred to Glasgow and Edinburgh respectively. Now, if this calculation were anything like correct, the Perth observation is entirely wrong; and the meteor could not have risen about 6° above the horizon of Durham, instead of 10° or 11° as estimated. I am unable, in any degree, to explain these conflicting results.

"3. The observations of Professor Kelland at Granton, and those at Perth, through the great azimuths of 125° and 130°, described by the meteor with such remarkable deliberation of motion, lead, when analyzed, to the very same results which presented themselves to the

mind of the spectator intuitively; namely, that the motion must have been sensibly rectilinear, equable, and parallel to the horizon at Edinburgh. Assuming that the greatest altitude at Edinburgh was 15°, and the bearing then N. 63° W. (true), we may calculate that the altitude should have been on this hypothesis, when first seen by Professor Kelland, 11° 47′,—instead of 12° as observed; at explosion, 6° 59′ (7° observed), and at its final disappearance 0° 47′ (instead of 0° 30′ observed). Again, at Perth the observed altitude, when first seen, was 3½°, and the calculated altitude 5° 3′, taking the maximum altitude at 17½°. The coincidence is, on the whole, remarkable, though it would be rash to push it to an extreme, as an error of some degrees may exist in the assumption of the direction of the meteor's course. Some later observations, received from Mr Curtis at Longford, and a consideration of the effects of perspective at Perth and Edinburgh, incline me to admit that the path might make an angle 3° or 4° greater with the meridian than I have above supposed. These conclusions are independent of the actual distance or parallax of the meteor; which, as I have said, cannot be determined without further observations, which I should be glad to receive from any quarter, but more particularly from Ireland, and from the centre and NW. of Scotland. If correct, they entitle us to infer that the meteor in question was most probably a body moving in space, in a path little curved, and not revolving round the earth."

3. Notes on the Purification and Properties of Chloroform. By William Gregory, M.D., Professor of Chemistry in the University.*

1. Chloroform has been prepared both from alcohol and from wood-spirit. The latter has been used for the sake of cheapness; but as it is a mixture of several liquids, all of which do not yield chloroform, it gives an impure product, in a proportion which varies much, but is always below that obtained from alcohol. There is

* Although I am alone responsible for the opinions contained in this paper, it is my duty to state, that all the experiments and observations mentioned in it have been made by me in concert with my able assistant, Mr Alexander Kemp, of whose ingenuity and accuracy I have had constant opportunities of judging.

therefore not only no advantage, but the contrary, in using wood-spirit, which is not, after all, much cheaper than alcohol.

2. But the chloroform from these two liquids, *when fully purified*, is quite identical in all its properties. Its smell, density, boiling point, and action on the system are, in both cases, exactly the same. That from alcohol is, no doubt, more easily purified than the other; but it also contains volatile oily impurities, which must be removed before it can be safely used. The peculiar oils which adhere to both kinds of chloroform are not identical, or, at least, not all identical; but they are of analagous constitution and properties.

3. Soubeiran and Mialhe have examined these oils. They contain chlorine, have a disagreeable smell, and, when inspired or smelt, cause distressing headache and sickness. In the case of wood-spirit, some of its own impurities distil over unchanged, and are found in the chloroform.

4. It is well known that many persons, after the use of chloroform, have suffered from headache, nausea, and even vomiting, as I have more than once seen. Headache and nausea I have myself experienced, when I have tried different specimens of chloroform, without taking so much as to produce the full effect.

5. Perfectly pure chloroform, such as is now on the table, does not, so far as I have seen or experienced, produce these disagreeable effects. It is, therefore, highly probable that when they occur, as they do with some individuals, from the use of chloroform of more than the average goodness of quality, this depends on the presence of a trace of these poisonous oils.

6. All good manufacturers of chloroform purify it by the action of oil of vitriol; which destroys the oils, while, at the same time, a part of the acid is reduced to sulphurous acid. The chloroform, to remove this, is then distilled with lime or carbonate of baryta, and is tolerably pure, if the process be well conducted.

7. But this is not quite pure, and contains a trace, more or less distinct, of the oils. I have found this to be the case with all the best chloroform made here, up to 1849; and I have several times seen headache and sickness from the use of such chloroform, which, as we all know, was the best anywhere made. I must add, however, that the quantity of oils was, although variable within certain limits, always, in the Edinburgh-made chloroform, so small, that it was fit for use, and only caused headache, &c., in a few peculiarly sensitive persons.

8. It was desirable to have a test for these impurities, as well as an easy and effectual mode of removing the last traces of them; especially as many sorts of chloroform, not made here, were far inferior in quality to that prepared in Edinburgh. One very delicate test is, that oil of vitriol, which should be quite colourless and pure (as it may be rendered by Mr Kemp's process, lately read to the Society), when agitated with the chloroform, becomes yellow or brown, from its action on the oils, which it chars and destroys. Any change of colour is easily seen by the contrast with the colourless chloroform which floats above. Pure chloroform gives no colour to the acid. It is essential that the oil of vitriol be colourless, and also of full density; for, if coloured, it is not easy to see a slight change in its colour; and if below the proper density, that is, too weak, it is not much coloured by a chloroform which will render brown the acid of proper strength.

9. Another test, still more delicate, I find to be the smell of the oils. When chloroform is poured on the hand or a handkerchief it rapidly evaporates; but the oils, being less volatile, are left behind, and their smell, previously covered by that of the chloroform, is easily recognised. Until very lately, no chloroform was sold, or, indeed, known, which would stand this test, or even the former.

10. Up to 1849, the best commercial chloroform had a specific gravity of 1·480, which was considered a guarantee of its purity. But it had been obtained, by chemists, of specific gravity 1·494 and even 1·497. I have found that chloroform of 1·480, when once more acted on by oil of vitriol, which destroys the oils and becomes brown, may be obtained, after removing the sulphurous acid, of specific gravity 1·500 at 60°. This I take to be the specific gravity of pure chloroform. Our best makers have lately, much to their credit, pushed the purification so far as to furnish chloroform even of this highest density, and also, in other respects, such as it ought to be.

11. There are still, however, many makers, in other places, whose chloroform is not so pure; and I shall now describe the method which, with Mr Kemp, I have employed for purifying, perfectly and easily, any commercial chloroform (except one remarkable specimen, of which more hereafter), a process which will enable any medical man to purify it for himself with the greatest facility.

12. The chloroform, having been tested as above, and found more

or less impure, is to be *agitated with* oil of vitriol (half its own volume will be sufficient), and *allowed to remain in contact with the acid;* of course in a clean, dry, stoppered bottle, and *with occasional agitation,* till the acid no longer becomes darker in colour. As long as the action is incomplete there will be seen, after rest at the line of contact, a darker ring. When this no longer appears, the chloroform may be drawn off, and, for greater security, once more acted on by a quarter of its volume of the acid, which should now remain colourless. It is now to be once more drawn off, and, in a dry stoppered bottle, mixed with a little powdered peroxide of manganese, with which it is gently agitated and left in contact, until the odour of sulphurous acid is entirely destroyed, and the chloroform has acquired a mild agreeable fruity smell. It has then only to be poured off into a proper phial. It will now leave no disagreeable smell when evaporated on the hand. (If the commercial chloroform, after having been *frequently well shaken,* and *left for some time in contact* with the acid, has given only a moderate tinge of colour to it, it is probable that it may be completely purified by that first process. To ascertain this, test a small portion in a tube with fresh acid, *shaking well,* and *allowing it to stand some time.* If it do not colour the acid at all, then the whole chloroform has only to be finally purified by the oxide of manganese. If the acid become coloured in the test tube, it will be as well to act on the whole chloroform a second time with fresh acid, till it stands the test. Mr Kemp has observed, in repeating this process for me, the very curious fact that, as soon as the action is complete and the oily impurities are destroyed, but not sooner, the chloroform tested with the acid in a tube exhibits a strongly convex surface downwards, where it rests on the pure acid, or, what is the same thing, the acid becomes concave at its upper surface. The smallest trace of impurity, not sufficient to affect the density of the chloroform, we have found to render the line of junction horizontal. It is probable that this may become a valuable test of the perfect purity of chloroform, but we shall not say more on this subject until we have thoroughly examined it.)

This process requires no apparatus beyond a few stoppered bottles, and a syphon, or a pipette, if we wish to draw off the whole chloroform without loss. The use of the oxide of manganese is due to Mr Kemp; and, on the large scale, the chloroform may be filtered

through a cylinder full of it. In this final purification of genuine, although not quite pure chloroform, no distillation is necessary.

13. It may be considered as certain, that the use of chloroform, thus purified, will very rarely, if ever, cause the disagreeable effects above noticed.* As to more serious bad results from the use of chloroform, so often spoken of elsewhere, it is enough to state, that a large proportion of the cases must be attributed to the use of a liquid so impure, as hardly to deserve the name of chloroform at all. Such a product, I rejoice to say, our Edinburgh manufacturers have never sold; and, I may add, that, no doubt chiefly in consequence of this, our practitioners have not yet seen a fatal result from the use of chloroform. But in London, and elsewhere, chloroform has been extensively sold, so bad, that I have examined specimens which did not contain half of their bulk of chloroform; others with not one third or one fourth; and I have seen one which hardly contained any at all. But, to make up for this, they were rich in poisonous oils, and

* Dr Simpson informs me, that the purest chloroform he has used not unfrequently causes vomiting. On further inquiry I find that this occurs when it is administered after a full meal. This can easily be avoided, and must not be confounded with the headaches, nausea, and vomiting alluded to in §§ 4 and 5; which symptoms are persistent, and occurred, in my experiments, always with an empty stomach, the experiments being made an hour or two before dinner. Dr Carmichael, assistant to Dr Simpson, has mentioned to me some facts which confirm the view I have taken. At one period, for more than a week, Dr Simpson and Dr Carmichael were kept in a state of continual anxiety by the occurrence, in all the puerperal cases in which chloroform was used, of very unpleasant symptoms, particularly of frequent pulse and other febrile symptoms, lasting for some days. At last, after much annoyance from this cause, it occurred to Dr Simpson that he was using one particular specimen of chloroform, supposed to be of good quality. As soon as this idea occurred, he threw away all that remained, and returned to that which he had generally used. The unpleasant symptoms no longer appeared. (I regret much that I had not an opportunity of examining that specimen; but I may add that the maker, not an Edinburgh one, now produces chloroform of much better quality, though not yet absolutely pure.) But the striking fact is this, that Dr Simpson and Dr Carmichael state, *that during the period above alluded to, when that one kind of chloroform alone was used by them, their handkerchiefs became quite offensive from the smell left on them, which even adhered to them after washing*. There can, I think, be no doubt that here the oily impurities alluded to in §§ 4 and 5 were present in notable quantity. I suspect that a majority of the specimens mentioned in the Table would have a similar effect, more or less marked. (I have since ascertained that this chloroform, which was much above the average in quality, *had not been subjected to the action of oil of vitriol in its preparation*, which strongly confirms the view I have taken. W. G.)

often in free hydrochloric acid. Very many specimens, although better than this, are yet so impure, that no one could, with comfort or safety, use them.

14. The chloroform now, and for some time past, made here, is of first-rate quality. I have two specimens which are absolutely pure, or nearly so; and a third, which is hardly inferior, all made and sold by Edinburgh manufacturers.

15. On the other hand, I have various specimens, maker unknown, besides some from makers in other places, which are not so pure, although, in general, much purer than those which I examined nearly three years ago. But one specimen deserves a separate notice. It is labelled "*pure chloroform*." It is yellowish, has a strong smell of the oils, and of impure wood-spirit; and, when treated with its own volume of oil of vitriol, developes much heat, colours the acid dark brown, and disappears almost entirely, any trace of chloroform it may contain being boiled off by the heat disengaged. It contains also so much free acid, that the cork is corroded. It is to be hoped that this product disgraces no longer the market. I do not know the name of its maker. Three of the specimens became milky, when mixed with the acid. One, after contact with the acid, acquired a strong smell of musk. Another lost about a third of its bulk. All but two coloured the acid decidedly at once; and all left, more or less, a disagreeable smell on the hand. One of the two which did not much colour the acid at first was that which acquired the smell of musk; the other, evaporated on the hand, left a white stain, depending partly on the matters present in the skin. This was the case also with another; yet these two coloured the acid but little at first, more strongly after a time: but both left a smell on the hand. Only one (Edinburgh made) specimen, of density 1·500, gave no colour, or only a perceptible tinge, to the acid.

16. In conclusion, I would remark, that while the use of chloroform in Edinburgh, in many thousand cases, has never yet led to a fatal result, I do not intend to maintain that the use of pure chloroform never can cause fatal effects. On the contrary, I have no doubt that, if rashly, carelessly, or ignorantly administered, so powerful an agent may, like any other powerful drug, especially in individuals of peculiar temperament, and in cases of severe, though latent internal disease, give rise to fatal results. That no such cases have here been met with is due partly to the good quality of the

chloroform used, and to the care with which it is prepared; and partly to the experience and judicious management of those whose duty it is to administer it, at the head of whom stands the introducer of chloroform, my friend and colleague, Dr Simpson.

It is much to be regretted that, in London and elsewhere, chloroform is not by any means so extensively employed as it ought to be, in consequence of the occurrence of some fatal cases, attributed (whether in all cases accurately or not, is a question) to the drug. There can be no doubt that most, if not all, of these cases have resulted from the use of very impure chloroform, such as even at a recent period was largely sold in London; and that, if pure chloroform alone had been employed, there would, by this time, have been no prejudice against its use. It is not, as I have shewn, necessary that chloroform should be very impure, in order to produce very disagreeable or even dangerous results. It is evident that even a small proportion of the oils above mentioned, if they are deleterious (and this cannot, I think, be doubted), will suffice, when applied in the form of vapour to the internal surface of the lungs, to act powerfully on the system. On the other hand, I am far from blaming those chemists who have manufactured impure chloroform for anything more than a want of due care in the preparation of an agent so energetic. And it is but fair to bear in mind that it was a new manufacture, hardly yet fully understood, and that those who made it were not probably aware, either of the existence of the impurities, or of the best mode of removing them. I have no doubt they did their best to produce a good article; and my chief object in this paper has been to put it in the power of every one to do so, and to point out strongly the bad effects of even a small amount of impurity.

While I acquit the makers of impure chloroform of any desire to adulterate it, I think it right to add that some of them must have been entirely ignorant of what was published concerning its properties. Thus some sold it of specific gravity 1·465, others of 1·347; and in the case of No. 8, which I have no doubt was under 1·000, although I had not enough to take its density accurately, the maker had evidently rejected the chloroform, and preserved the lighter liquid floating over it!—not knowing even that chloroform was a heavy liquid. It is lamentable to think that persons so ignorant are free, by our laws, to set up as makers of the most potent drugs.

I may here add, that no *rectification* at all is required from the first, if the chloroform be only washed with water till its volume no longer diminishes, and then treated, as above, with concentrated sulphuric acid.

It is possible that some of the fatal cases may have occurred from an injudicious mode of administering the vapour, or from the operator intrusting the administration to persons not qualified to recognise those signs which tell the experienced practitioner that it is time to stop. There ought always to be two well-qualified persons present, —one to watch, without intermission, the effects of the vapour, which he also administers as required; the other, of course, to operate. He who gives the chloroform must carefully attend to the state of the respiration, as has been often recommended by Dr Simpson. But these are matters beyond the proper province of this paper, and I leave them them to those who are better qualified than I am to discuss them.

I have only to add, that this paper was written and read before I heard of a recent article in "Chambers' Journal" on the subject; and that I had not the remotest knowledge of or concern in that article, which I have not yet seen, although, as I am told, the author of it agrees with some of my conclusions in regard to the employment of chloroform in London.

A tabular view of the properties of chloroform will be found on the following page.

Tabular View of the Properties of Chloroform.

Variety of Chloroform.	Specific Gravity at 60°.	Action of Concentrated Sulphuric Acid.	When evaporated on hand.	General Remarks.
No. 1	1·347	Became milky and yellow, changing to brown. After twenty-four hours, very dark brown; it also diminished in volume.	Left a strong smell.	The low density here at once proves the great impurity. In contact with the acid, it lost one-fifth or one-fourth of its volume. Very dangerous to use.
No. 2	1·465	The same as No. 1, except that it did not diminish nearly so much; after 24 hours, it had become very dark.	The same as No. 1.	Density also far too low, but less impure than No. 1. Both would be very unsafe to use.
No. 3	1·495	Scarcely affected, on mixture at first; after some time very dark, it also acquired a distinct smell of musk.	Left a very distinct smell.	This is much better than Nos. 1 or 2, but yet not pure.
No. 4	1·475	Became milky and thin yellow; after 24 hours, very dark brown.	The same as No. 1.	Resembling No. 2; probably the same maker.
No. 5	1·495	Became milky yellow, and afterwards brown, but diminished only slightly in volume; darker after 24 hours.	Distinct smell.	Of tolerable quality, but not pure.
No. 6	1·490	Became slightly yellow, but did not diminish much in volume; brown after 24 hours.	Very distinct smell.	Nearly as No. 5.
No. 7	1·495	Little colour developed at first; after frequent shaking and 24 hours contact, dark brown.	Distinct smell.	Rather better than Nos. 5 and 6. The chloroform mentioned in the note, p. 320, was not, I believe, inferior to this.
No. 8		Became dark brown, and very hot. Nearly the whole of it dissolved in the oil of vitriol used.	Left a very strong and disagreeable smell.	This certainly did not contain more than one-thirtieth of chloroform. It had not even the smell of that substance, and contained much free hydrochloric acid, as well as the poisonous oils, in large proportion. The use would be most dangerous.
No. 9	1·500	Became very pale yellow, afterwards dark brown.	Distinct smell.	The full density, and very nearly pure. Quite fit for ordinary use; although it might easily be rendered quite pure.
No. 10	1·500	Very slight change.	Just perceptible smell.	Full density. It can hardly be distinguished from the purest chloroform I have myself prepared. But even this did not exhibit the convex surface downwards, when resting on the acid.
No. 11	1·490	Became dark brown after a time, as No. 4.	Distinct smell.	Not sufficiently pure for use; but better than several others.
No. 12	1·490	As No. 9. Slightly coloured at first; after some time, and frequent shaking, dark brown.	Distinct but slight smell.	This, as well as Nos. 3, 5, 6, 7, and 11, would all have been called quite pure two years, or even one year ago. But all of these require to be purified.

The following Donations to the Library were announced:

Some Account of the last Yellow Fever Epidemic of British Guiana. By Daniel Blair, M.D. Edited by John Davy, M.D., F.R.S.L. & E. 8vo.—*By the Author.*

Das peripherische Nervensystem der Fische, Anatomisch und Physiologisch untersucht von Dr Hermann Stannius. 4to.—*By the Author.*

Neue Denkschriften der Allg. Schweizerischen Gesellschaft für die gesammten naturwissenschaften. Bd. x., mit. xiii. Tafeln. 4to. —*By the Society.*

On the Diffusion of Liquids. By Thomas Graham, Esq., F.R.S., F.C.P. 4to.—*By the Author.*

Description of the Instruments and Process used in the Photographic Self-registration of the Magnetical and Meteorological Instruments at the Royal Observatory, Greenwich. 4to.—*By the Astronomer-Royal.*

Proceedings of the Royal Astronomical Society. Vol. X., No. 4. 8vo.—*By the Society.*

Description of the Observatory at Cambridge, Massachusetts. By William Cranch Bond. 4to.

Astronomical Observations made at Cambridge Observatory, Massachusetts, 1847–8. 8vo.—*By the Observatory.*

Monday, 1st April, 1850.

Gen. Sir T. MAKDOUGALL BRISBANE, Bart., in the Chair.

4. On a Peruvian Musical Instrument, like the ancient Syrinx. By Dr Traill.

The author prefaced his description of the instrument, by a few general remarks on the communication, in very remote epochs, between the inhabitants of the old and new worlds, as deducible from affinities in their traditions, their cosmogenies, their religious rites and structures, their astronomical cycles, and their determination of the length of the year.

The Peruvian instrument was discovered, some years ago, in a *huaco*, or vast tumulus, that was believed to cover the remains of an Inca of Peru. It is not of unequal reeds, like the Greek syrinx, but is cut out of a piece of *potstone*, of a trapezoidal form, in which are cut eight tubular holes of unequal depths. These tubes or holes are of equal diameter, and have been carefully made with some sort of drill. The breadth of the instrument, including a short handle, is 6·2 inches; its greatest depth, 5·3 inches; and the thickness of the stone varies from 0·7 to 0·5 inch. The instrument in principle and in form is analogous to the *Pan's pipe* of antiquity, or to the *organetto* of modern Italy; but has one remarkable difference in a small ventilage on each of four of its pipes; when one is uncovered, that pipe is mute, but when covered by the fingers of the player, the full sound is produced.

A strolling Italian, who performed well on the *organetto*, was employed for several evenings to play on the Peruvian instrument; and, with the assistance of three skilful musical friends, one of whom was an adept on the violoncello, the author of the paper was enabled to ascertain the scale of the instrument. This scale extended from E on the lower line, through F sharp, G, A, D, C sharp, F to A, above the lines. By means of the ventilages, the ordinary notes of the instrument seemed to be divisable into two tetrachords,—one in the key of E minor, the other of F major—the first a perfect tetrachord; the second, nearly so.

The form of the instrument and its use have a striking similarity to the Syrinx of the Greeks, the invention of which was ascribed to the god Pan, or to Egypt; and it is worthy of notice, that the great musical system of the Greeks also consisted of tetrachords. A syrinx of unequal reeds was found by the celebrated Humboldt, in the hands of the natives, on the banks of the Orinocco. It is in use among the Arabs of the desert, and a similar instrument, composed of twelve unequal reeds, is figured by Kæmpfer among the instruments of the Japanese.

2. Some Remarks on Cometary Physics. By Professor Piazzi Smyth.

That theories of the physical appearances of comets have generally failed, appeared to the author to arise from the facts having been misunderstood or misinterpreted in general by the observers themselves.

As a particular instance of this, the wide-spread notion of comets shooting forth their tails, at, or a little before the perihelion passage, and drawing them in again afterwards, so as to be larger at that period of their orbits than at any other, was mentioned; and in place of which, the author shewed that the comets were at the perihelion, of their smallest size; the tails becoming then more visible, not from being actually produced at that time, but from being more dense, and illumined by a stronger solar light, as well as being in general seen from a smaller terrestrial distance.

The author then proceeded to collect together the facts which he thought well made out with regard to comets; to describe the corrections which the apparent, required, to give the true phenomena; and to detail the various practical methods by which better observations might be procured.

The so-called established facts mentioned above, were collected in a series of axioms, which are here appended; as they seem to be worthy of being discussed, and either disproved or assented to, by astronomers.

1*st*, A comet consists of a nucleus, and one or more gaseous envelopes.

2*d*, The nucleus, if solid and material, is infinitely small.

3*d*, The nucleus is excentrically situated in the gaseous body.

4*th*, Comets of longest period have the largest bodies.

5*th*, Those comets whose orbits have the greatest excentricity, are the most excentrically situated in their envelopes, or, vulgarly, have the longest tails.

6*th*, A comet revolves on an axis passing through the nucleus, and at right angles to the major axis of the envelope, in the same period of time that it takes to revolve about the sun; hence the tail being turned away from the sun in the normal position, is turned away from him in all other parts of the orbit also.

7*th*, This axis is not at right angles to the plane of the orbit, but variously inclined in the case of different comets, as with the planets.

8*th*, A quicker rotation round the longer axis of the body also appears to exist.

9*th*, A comet shines by reflected light, and shews a sensible phase.

10*th*, The gaseous envelope is of extreme tenuity, is elastic, and,

with regard to light, is slightly reflective and imperfectly transparent; it decreases in size, but increases in density and light reflective power in approaching the perihelion, and the reverse when receding from it; and this occurs in a degree proportioned to the excentricity of the orbits of the comets.

11*th*, The axis of the tail of a comet is straight at the perihelion, but at any point between this and the aphelion, is curved; and is concave towards the latter, the radius of curvature being inversely as the excentricity of the orbit.

12*th*, The molecules composing the envelope of a comet are only held together by their mutual gravitation, each constituting almost a separate independent projectile, and describing its own parabola about the sun.

3. Abstract of Professor Kelland's Exposition of the Views of D. R. Hay, Esq., on Symmetric Proportion.

The fundamental hypothesis of the author was stated to be this:—That the eye is capable of appreciating the exact subdivision of spaces, just as the ear is capable of appreciating the exact subdivisions of intervals of time; so that the division of space into an exact number of equal parts will affect the eye agreeably in the same way that the division of the time of vibration in music, into an exact number of equal parts, agreeably affects the ear. But the question now arises, What spaces does the eye most readily divide? It was stated that the author supposes those spaces to be angles, not lines; believing that the eye is more affected by direction than by distance. The basis of his theory, accordingly, is, that bodies are agreeable to the eye, so far as symmetry is concerned, whenever the principal angles are exact submultiples of some common fundamental angle. According to this theory we should expect to find, that spaces, in which the prominent lines are horizontal and vertical lines, will be agreeable to the eye, when all the principal parallelograms fulfil the condition that the diagonals make with the sides, angles which are exact submultiples of one or of a few right angles. This application of the theory was exemplified by a sketch of the new Corn Exchange erected in the Grassmarket by David Cousin Esq., whose beautiful design was shewn to have been constructed with a special reference to the fulfilment of this condition.

The author was stated to proceed to apply his theory to the con-

struction of the human figure, in which we should expect *à priori* to find the most perfect development of symmetric beauty. Diagrams were exhibited which represent, with remarkable accuracy, the human figure; and it was explained that not a single lineal measure is employed in their construction. The line which shall represent the height of the figure being once assumed, every other line is determined by means of angles alone. For the female figure, those angles are, one-half, one-third, one-fourth, one-fifth, one-sixth, one-seventh, and one-eighth of a right angle, and no others. It must be evident, therefore, that, admitting the supposition that the eye appreciates and approves of the equal division of the space about a point, this figure is the most perfect which can be conceived. Every line makes with every other line a good angle. The male figure was stated to be constructed upon the female figure by altering most of the angles in the proportion of 9 : 8; the proportion which the ordinary untempered flat seventh bears to the tonic.

A drawing was exhibited, which had been designed with great care from the life, by the distinguished academician John A. Houston, Esq. On this drawing the author had constructed his diagrams; and the coincidence of theory with fact was seen to be complete. Professor Kelland concluded by claiming for the author the attention of the Society. He argued, that a principle so simple and comprehensive in its character, and thus far apparently truthful in the conclusions to which it leads, merits, and should receive, the most complete and rigid examination. Whatever might be the ultimate result (and it promised to be satisfactory in the extreme), the ingenuity, energy, and zeal, shewn by the author, entitle him to our warm approbation.

The following Donations to the Library were announced:

Magnetical and Meteorological Observations made at the Royal Observatory, Greenwich, 1847. 4to.—*From the Observatory.*

Journal of the Statistical Society of London. Vol. XIII., Part 1, 8vo.—*By the Society.*

Deuxième Mémoire sur le Daltonisme, ou la Dyschromatopsie, par E. Wartmann. 4to.—*By the Author.*

The Accommodation of the Eye to Distances. By William Clay Wallace, M.D. 8vo.—*By the Author.*

Transactions of the Zoological Soc. of Lond. Vol. III., Pts. 5 & 6. 4to.
Proceedings of Do. Parts 15 & 16. 8vo.
Reports of Council of Do. 1849. 8vo.—*By the Society*.

Monday 15th April.

Rev. Dr GORDON in the Chair.

The following Communications were read:—

1. On the Constitution of Codeine, and its Products of Decomposition. By Thomas Anderson, M.D.

The author commenced his paper by referring to the analysis of codeine made by different chemists. On these analyses four different formulæ had been founded; but two only, those of Regnault and of Gerhardt, required special mention, the others being now known certainly not to represent the constitution of the base. Regnault had deduced from his analysis the formula $C_{35}\ H_{20}\ NO_5$, while Gerhardt gives $C_{36}\ H_{21}\ NO_6$ as the expression of his results.

The author submitted codeine to careful analysis, and obtained the following results:—

					Calculation.
Carbon,	71·91	72·02	72·09	72·09	72·24
Hydrogen,	7·05	7·04	7·14	7·16	7·02
Nitrogen,	4·41	4·60	4·50	...	4·68
Oxygen,	16·63	16·34	16·27	...	16·06
	100·00	100·00	100·00		100·00

agreeing closely with the formula $C_{36}\ H_{21}\ NO_6$, and confirmed by the analysis of its platinum salt, which contains an equivalent of water, and gave, as the mean of seven experiments, 19·25 per cent. of platinum, while the calculated quantity is 19·19 per cent.

The author then describes in detail the properties and constitution of its salts. The hydrochlorate crystallizes in groups of short radiated needles, the formula of which is $C_{36}\ H_{21}\ NO_6\ HCl + 4\ HO$. The hydriodate is obtained in long needles, which, dried at 212°, retain two equivalents of water, and have the formula $C_{36}\ H_{21}\ NO_6\ HI + 2\ HO$. The sulphate, nitrate, phosphate, oxalate, hydrosulphocyanate, and platinochloride are also described.

The author then proceeds to the consideration of the products of decomposition of codeine.

When treated with strong sulphuric acid, codeine passes into an amorphous condition, similar to that in which quinine is obtained when treated with an excess of acid, and in which state it forms resinous compounds with acids.

With dilute nitric acid it gives a new base, nitrocodeine, the formula of which is $C_{36} H_{20} (NO_4) NO_6$, which is precipitated from its solution by ammonia, in minute silvery crystals, sparingly soluble in water, but dissolving readily in alcohol and ether; and crystallising on cooling in small yellowish needles. It dissolves readily in acids, with the formation of salts, which have a more or less yellow colour; and all crystallize except the hydrochlorate. Of these the hydrochlorate, sulphate, oxalate, and platinochloride are described.

By the action of bromine, two different bases are obtained—bromocodeine and tribromocodeine. The first of these is prepared by adding bromine water to powdered codeine until it is dissolved, and then precipitating with ammonia, when the base is thrown down as a crystalline powder, which is obtained in needles by solution in boiling water or alcohol. Its formula in the crystallized state is $C_{36} H_{20} Br NO_6 + 3 HO$. Its salts are similar, in most of their properties, to those of codeine, and all crystallize in small needles. By the further action of bromine, a yellow powder, sparingly soluble in water, is obtained, which is the hydrobromate of tribromocodeine, and from which the base is obtained by solution in hydrochloric acid, and the addition of ammonia. Tribromocodeine is a gray powder, insoluble in water and ether, but soluble in alcohol; it is an extremely feeble base, but dissolves in acids and forms salts, all of which are sparingly soluble in water and amorphous. Its formula is $C_{36} H_{18} Br_3 NO_6$.

The author found that chlorine, by acting upon codeine, gave rise to amorphous compounds, which were not obtained of definite constitution; but by the use of a mixture of chlorate of potash and hydrochloric acid he obtained chlorocodeine, $C_{36} H_{20} Cl NO_6$, similar in its general properties and constitution to bromocodeine, and resembling that substance so closely that it may be easily mistaken for it.

By the action of cyanogen another base was obtained. This

substance is best prepared by passing cyanogen into codeine dissolved in the smallest possible quantity of alcohol. The gas is rapidly absorbed, and there is deposited from the solution a mass of crystals which, when dissolved in alcohol, are obtained in six-sided plates, with a fine silvery lustre. These crystals gave to analysis the following results:—

Carbon,	68·22	68·04
Hydrogen,	5·93	6·17
Nitrogen,	11·81	11·50
Oxygen,	14·04	14·27

and the author attributes to them the formula $C_{36}\,H_{21}\,NO_6\,2\,C_2\,N$, and gives to the substance the name of bicyanocodeine. It is a base; but owing to its extreme instability, no salts could be obtained. When treated with an acid it is rapidly decomposed, ammonia being formed, and, after a time, hydrocyanic acid evolved.

By treating codeine with a mixture of potash and lime, at a temperature of 250° Fahr., it undergoes slow decomposition, and a volatile base is evolved, which differs according to the circumstances of the experiment. The author found that, under certain circumstances, the base evolved had the formula $C_6\,H_9\,N$, and forms the term in the series of bases homologous with ammonia, which corresponds to metacetonic acid, and which may be called metacetamine. Under other circumstances the base evolved had the formula $C_2\,H_5\,N$, and corresponded, in all its properties, with the methylamine of Wurtz.

The following is a tabular view of the constitutions of the substances described in this paper:—

Codeine, . . .	$C_{36}\,H_{21}\,NO_6$.
... crystallised, .	$C_{36}\,H_{21}\,NO_6 + 2\,HO$.
Hydrochlorate, . .	$C_{36}\,H_{21}\,NO_6\,HCl + 4\,HO$.
Hydriodate, . .	$C_{36}\,H_{21}\,NO_6\,HI + 2\,HO$.
Sulphate, . . .	$C_{36}\,H_{21}\,NO_6\,HO\,SO_3 + 5\,HO$.
Nitrate, . . .	$C_{36}\,H_{21}\,NO_6\,HO\,NO_5$.
Phosphate, . .	$(C_{36}\,H_{21}\,NO_6\,HO)\,2\,HO\,PO_5 + 3\,HO$.
Oxalate, . . .	$C_{36}\,H_{21}\,NO_6\,HO\,C_2\,O_3 + 3\,HO$.
Hydrosulphocyanate, .	$C_{36}\,H_{21}\,NO_6\,HC_2\,NS_2 + HO$.
Platinum salt dried at 212°, . .	$C_{36}\,H_{21}\,NO_6\,HCl\,Pt\,Cl_2 + HO$.
... crystallised, .	$C_{36}\,H_{21}\,NO_6\,HCl\,Pt\,Cl_2 + 3\,HO$.

Amorphous codeine, .	$C_{36} H_{21} NO_6$.
Nitrocodeine, . .	$C_{36} H_{20} (NO_4) NO_6$.
Sulphate, . . .	$C_{36} H_{20} (NO_4) NO_6 HO SO_3$.
Platinum salt, . .	$C_{36} H_{20} (NO_4) NO_6 HCl Pt Cl_2 + 4 HO$.
Bromocodeine, . .	$C_{36} H_{20} Br NO_6$.
... hydrate, . .	$C_{36} H_{20} Br NO_6 + HO$.
... terhydrate, .	$C_{36} H_{20} Br NO_6 + 3 HO$.
Hydrobromate, . .	$C_{36} H_{20} Br NO_6 HBr + 2 HO$.
Platinum salt, . .	$C_{36} H_{20} Br NO_6 HCl Pt Cl_2$.
Tribromocodeine, .	$C_{36} H_{18} Br_3 NO_6$.
Hydrobromate, . .	$2 (C_{36} H_{18} Br_3 NO_6) 3 HBr$.
Platinum salt, . .	$C_{36} H_{18} Br_3 NO_6 HCl Pt Cl_2$.
Chlorocodeine, . .	$C_{36} H_{20} Cl NO_6$.
... terhydrate, .	$C_{36} H_{20} Cl NO_6 + 3 HO$.
Sulphate, . . .	$C_{36} H_{20} Cl NO_6 HO SO_3 + 4 HO$.
Platinum salt, . .	$C_{36} H_{20} Cl NO_6 HCl Pt Cl_2$.
Bicyanocodeine, . .	$C_{36} H_{21} NO_6 2 C_2 N$.
Metacetamine, . .	$C_6 H_9 N$.

2. On the *Physical* and Scottish *Statutory* Limits of Sea and River, as applicable to Salmon Fisheries. By Dr Fleming.

Dr Fleming directed the attention of the Society, in the first instance, to the characteristic features of *sea* and *river* proper; and then proceeded to consider the peculiarities of that *common space*, alternately sea and river, to which he restricted the term *estuary*. He then considered the nature of the space between high and low water, and pointed out the *mean level*, or mid-tide mark, as the only constant and universally applicable boundary plane. The influence of the tidal wave in reversing the current, checking the velocity, and increasing the depth of the river, was next brought under notice, and an experiment exhibited, illustrating the conservation of force, which causes the waters at the head of an estuary, and the connected river, in certain circumstances, to attain a *higher level* than the high-water mark of the neighbouring sea-shore. He then considered, successively, the tests which, on different occasions, had been proposed and employed; viz.—point of stagnation; presence of sea or river water; the growth of sea-weeds; fauces terræ; deltas and bars; and pointed out their uselessness in determining the physical limit between sea and river.

The second part of the paper was occupied with an examination of the Scottish *statutory* limit of sea and river, as applicable to the salmon fisheries; in which the author indicated *low-water mark, as the only limit contemplated*, and justified the sagacity of our ancient legislators, by proving that, with this limit, the object of the statutes was secured. He pointed out the inapplicability of the *physical* test which he had previously established, and of the spurious ones which had been noticed, to the settlement of the fishery question. He concluded, by expressing his regret, that the Legislature had declared certain engines, for catching fish, to be legal or illegal, according as they are used in sea or river, without defining what is *sea* or what is *river;* and his expectation that, should any bill be brought into Parliament, in connection with this subject, the present state of the law will not be permitted to remain in *culpable obscurity.*

3. On the Combined Motions of the Magnetic Needle, and on the Aurora Borealis. By J. A. Broun, Esq. Communicated by Sir T. M. Brisbane, Bart.

When a steel needle or rod is so constructed that its centre of gravity is in a finely-turned axle at right angles to its length, it will rest in any position when the axle is placed upon polished planes; when, however, we magnetize the needle, it assumes a position which is that of the direction of the magnetic force at the place: in this way we obtain the ordinary dipping-needle. The dipping-needle can obviously move only in one plane, that to which the axle is at right angles; were it possible to suspend it freely, so that it could move in every plane with every variation of the direction of the magnetic force, we should then be able, by observing the variations of its position, to determine at once the laws which a magnet in its true position obeys; this, however, we have not been able to do; even the small variations in the vertical plane, which we might expect to obtain from the ordinary dipping-needle, are nearly or altogether destroyed by the friction of the axle upon its supports; and there are many mechanical difficulties in the way of the other methods of suspension. It has been found convenient, then, to make use of the simplest methods of suspending magnets in a horizontal plane; and to endeavour to deduce, from the composition of their motions, the

laws both of the variation of the force with which a truly suspended magnet is directed, and of the direction of that force itself.

The most convenient of these is that termed the declination magnet, which is suspended horizontally by a fine silken thread; the tendency of the needle to dip being obviated by placing the point of suspension north of the centre of gravity. This instrument is very convenient, especially in high latitudes, for exhibiting in a magnified form that portion of the motion of the freely suspended dipping-needle, which is at right angles to the vertical plane of the needle. Two other instruments, one termed the bifilar magnetometer, from its suspension by two threads; the other named the balance magnetometer, from its resemblance to the beam of a balance, enable us to observe the variations of the horizontal and vertical components of the force with which the freely suspended dipping-needle is directed; whether these variations be due to a change in the total value of the force, or simply to a change in its direction parallel to the vertical plane. In high magnetic latitudes, the bifilar or horizontal component magnetometer will be most affected by changes of the direction of the force in the vertical plane, and the balance or vertical component magnetometer will be most affected by variations of the intensity of force: in low latitudes the reverse is the case. In all three instruments the magnets are forced from their natural position. By means of a well-known formula, however, we can compute, from the observed variations of the two components, the variations of the total force, and of its direction in the plane of the magnetic meridian. Theoretically this operation is simple enough, but practically there are great difficulties; these difficulties are due to the effect of temperature upon the positions of the bifilar and balance magnets, which require to be eliminated, and to sources of error that I have pointed out in the Edinburgh Transactions in the determinations of the change of value of either component of force, which corresponds to a change of, say one minute in the angular positions of the magnets. I conceive that I have, by the employment of new methods, reduced the errors due to these causes to a very small amount; and it is for this reason that I claim for the results deduced from the Makerstoun Observations, a consideration which they could not otherwise have been entitled to. I refer to the part of the Transactions now in the press, for the results relative to the *separate* magnetic elements, and to the total force; I confine myself at present to those touching the

motions of a magnet supposed freely suspended in the direction of the magnetic force.

I may state shortly the process by which the following results have been arrived at. The corrected observations for each of the three magnetometers having been discussed with reference to a particular argument; such as, the month, the moon's age, the moon's position in declination, the sun's hour angle, and the moon's hour angle; the motion of the (supposed) freely suspended needle at right angles to the plane of the magnetic meridian, was obtained with reference to the argument in multiplying the corresponding variations of declination by a constant factor (the cosine of the dip); the motion parallel to the same plane was obtained from the variations for the two components by the formula already referred to; the value of the former part of the motion for any epoch being taken as the abscissa, and that of the latter for the same epoch as the ordinate, the motion of the north end of the needle is constructed.

Annual Motions.—The difficulty of determining the law of annual variation of any of the magnetic elements has been so great, that it is doubtful whether that for the magnetic declination has ever been obtained, though the instrument upon which its determination depends is unaffected by variation of temperature. I believe that I have succeeded in the determination of the laws of all the elements, and from these the annual motion has been constructed. The annual motion deduced from the observations of the three magnetometers for the four years 1843, 1844, 1845, and 1846, is shewn in figure A; another and rather more symmetrical figure, deduced from a different combination of years, is shewn in figure B, Plate VI., Edin. Trans., Vol. xix., Part 2.

From near the vernal till the autumnal equinox the annual motion forms the half of an ellipse whose major axis, passing at the vertex through June, makes an angle of about $+11^\circ$ in figure A and of $+16^\circ$ in figure B with the projection of the magnetical meridian. At the autumnal equinox the north end of the needle again ascends till the winter solstice, after which it descends till the vernal equinox. In its descent, the north end of the needle having crossed its previously ascending path, it forms a loop which, when untwisted and continued downwards from the equinoxes, completes the ellipse; the portion formed by the loop having almost exactly the same perimeter as that regularly formed when the sun is north of the equator;

the completed portion is indicated by dotted lines in figures A and B. It does not seem improbable that in southern latitudes the figure will be inverted, and that it will be a simple ellipse near the equator.

Monthly Motions.—The motion corresponding to the moon's varying phase has not been projected, chiefly because of the irregularities still existing in the result of the four years' observations for the magnetic declination, the epoch of minimum being ill-determined; it is conceived that the figure is a simple ellipse with its major axis in the astronomical meridian, the northern extremity being at conjunction, the epoch of minimum dip, and the southern extremity at opposition, the epoch of maximum dip; this, however, is doubtful.

The motion for the moon's position in declination has been obtained in the following manner:—Having first projected the means of magnetic declination for *each* three days of the moon's position in declination, as obtained from the Tables for the years 1843–6, the day after the farthest northerly position being the abscissa, a curve was passed freely among the points; the values of the ordinates at the points of intersection by the curve were then taken as the interpolated value of magnetic declinations for the corresponding abscissæ: a similar operation was performed for the magnetic dip. In both cases very satisfactory curves, agreeing nearly with the true points, were obtained. These values are projected in figure C, Plate VI., Edin. Trans., Vol. xix., Part 2. From this figure the north end of the dipping-needle commences its ascent about two days after the moon is north of the equator, attains its highest point about two days after the moon is farthest north, and afterwards it descends till the moon is again near the equator; thus forming a figure like a portion of an ellipse with its vertex about one day after the moon is farthest north, the major axis making an angle of about $-30°$ with the magnetic meridian. It will be remarked that so far this motion is quite similar to that for the sun's position in declination, with the exception of the axis of the figure being on the opposite side of the magnetic meridian; when we trace the figure farther, the analogy still subsists;—as the moon proceeds south of the equator the north end of the needle again ascends till the moon is farthest south, thereafter descending, and, in crossing its previously ascending path, a loop is formed lying partially out of the principal figure, as in the case of the annual motion.

The correspondence of the two results gives a great weight to the accuracy of both; this will be more evident when it is remembered, that the whole motion of the dipping-needle for the moon's varying declination is included by a small circle with a diameter of little more than *one-tenth of a minute of space*, and, that no observation in the sixty thousand employed for this result has been rejected, however greatly affected by disturbance; although the graphic interpolation to remove slight irregularities may be considered as an equivalent operation.

Diurnal Motions.—The monthly mean diurnal variations for the magnetic declination and magnetic dip, from four years' observations, still present irregularities, especially from 10^h P.M. till 4^h A.M., the hourly positions for this time depending on only two years' observations. For this reason, the values from the Tables having been projected, curves were passed freely among the points, and the interpolated ordinates thus formed, were taken for the projections in Plate VII.: the interpolated quantities differ very little from the actual values, and this is especially the case for the summer months.

The diurnal motions for the four winter months, November to February, are of the same class, and they differ considerably from those for the other months (see Plate VII.): in each of these months the motion consists of a figure of two closed loops: the north end of the needle moves eastwards with little change of dip from about 1^h P.M. till 9^h or 10^h P.M., after which it turns westwards, and begins to ascend about 4^h A.M., crossing near its position at 6^h P.M.; thus forming an eastern loop, which is small compared with the western loop, excepting in December. After 6^h A.M., the north end of the needle having moved a little westwards, again descends, crossing a second time the afternoon track near 5^h P.M.; still moving westwards, it ascends about 11^h A.M. till it meets the position of 1^h P.M., thus completing the western loop. The eastern loop is not formed in March, the north end of the needle not rising sufficiently high to cross the afternoon track. The change in the figure from February to March is very great; in April and May the remains of the eastern loop are still visible, but in June and July its position is indicated by a simple inflection in the figure; in August and September the germ of the eastern loop becomes more distinct, and in October the loop is actually formed. The transition in form from autumn to winter is quite gradual, unlike that from winter to spring. In the

winter months, the principal or western loop is formed by the motion from 8^h A.M. till 5^h P.M.; in the months from April to August, three-fourths of the whole diurnal motion occur between 6^h A.M. and 6^h P.M., the remaining fourth forming a slightly inflected side to each of the figures: it is this side which is gradually twisted up to form the eastern loop of the winter months.

It is evident that no proper comparison can be made of the areas of these figures on account of the involved forms in the winter months; the areas, however, of the figures from April to August, differ very little.

Perimeters of the Figures.—The twisting of the perimeters, which renders a comparison of the areas of little value, does not appear to affect the length of the motion, and this therefore seems a fair subject for examination. The following are the values of the angular motion, or length of the perimeter, for each month, as obtained approximately from Plate VII.

Jan.	Feb.	March.	April.	May.	June.
5′·60	6′·16	9′·22	12′·18	12′·04	12′·00
July.	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
11′·56	11′·64	10′·48	9′·78	7′·22	5′·84

December and January shew the least perimeters, April, May, and June, the greatest, though the perimeters for the months from April to August are nearly constant.

Hourly Angular Motions.—Having obtained the approximate motion from hour to hour for each of the monthly figures, we find that, on the whole, they follow nearly the same law, that indicated in the following numbers, which are the means for each two hours of the *hourly* motions from the 12 separate months.

12^h	14^h	16^h	18^h	20^h	22^h	0^h	2^h	4^h	6^h	8^h	10^h
0′·43	0′·48	0′·46	0′·62	1′·19	1′·60	1′·34	1′·08	0′·99	0′·60	0′·57	0′·29

These numbers give the following curious result;—That the velocity of motion of the north end of a magnet freely suspended in the direction of the magnetic force is a maximum when the sun makes its superior transit of the magnetic meridian (between 10^h and 11^h A.M.), and a minimum when it makes its inferior transit of the same meridian (between 10^h and 11^h P.M.). This result is the more curious that the epoch of the minimum velocity of the diurnal motion is an epoch of maximum disturbance; and, in as far as the declination is con-

cerned, the epoch of maximum velocity of the diurnal motion is also an epoch of minimum disturbance.

When we compare the results for the irregular disturbance, with reference to the separate elements of magnetic declination and magnetic dip (see Ed. Trans., Vol. xix., Part 2), with the velocities of motion as deduced from these figures, we find, that *when the diurnal motion is most rapid the departures from the direction of that motion are least*, and *when the diurnal motion is slowest the irregular departures from the hourly mean position are greatest.*

Thus, if we examine the mean disturbance of magnetic declination for each hour, as deduced from two years' observations, we find it a maximum during the hours from 8 P.M. till 2 A.M.; this is the period for which the motion of the needle is at once slowest and least as regards the declination; about 21^h (referring to the figure for the year, see Plate VIII., Edin. Trans., Vol. xix., Part 2), the motion is most rapid and nearly altogether in declination, the minimum disturbance in declination occurs immediately before this hour; another and nearly equal minimum occurs under the analogous circumstances about 5^h P.M.; a secondary maximum occurring about 1^h or 2^h P.M.

If we approximate to the hourly mean disturbance of the magnetic dip by means of those deduced for the two components of force, we find the *minimum* to occur about 6^h–7^h A.M., when the velocity of motion is considerable, and when almost wholly in the *direction* of dip; the disturbance increases from that time till about 2^h A.M., shewing a secondary minimum about 1^h P.M. and about 8^h P.M., at both of which times the direction of motion is chiefly that of dip: the maximum disturbance occurs from about 10^h P.M. till 3^h A.M., during which period the velocity of motion is least.

On the whole, then, the magnetic disturbance appears to be chiefly at right angles to the direction of the motion of the needle, and to be inversely as the velocity of motion.

It is scarcely possible to connect the previous facts of area, perimeter, or velocity of motion with the laws of variation of temperature. In the mean for the whole year, the temperature changes most rapidly between 8^h and 9^h A.M.; but it changes with nearly equal rapidity between 5^h and 6^h P.M. There is no corresponding fact in the previous numbers. When we compare the variations of temperature with the variations of position for the suspended mag-

net in the summer months, we find the difference between the two classes of facts even more marked: in summer, the temperature changes most rapidly about 7^h A.M. and 7^h P.M., the change for May, June, and July, from 6^h–8^h A.M., being $+ 3°·80$, and from 6^h–8^h P.M., being $-3°·54$; for the same months, the mean angular motion of the needle from 6^h–8^h A.M. $=1'·00$, from 9^h–11^h A.M. $=2'·12$, and from 6^h–8^h P.M. $=0'·74$. There is a diminution in the velocity of the motion between 1^h and 2^h P.M. ; there is also a slight diminution at the turning point, 6^h–7^h P.M., and between 2^h and 3^h A.M. These diminutions appear to be connected with the fact, that they occur at turning points in the figures.

It may be remarked that the line representing the astronomical meridian, and passing through the centre of gravity of the perimeters of the figures, for the months during which the sun is north of the equator, also passes through the position of greatest velocity, and nearly through that of least velocity, of the diurnal motion.

General Form and Turning Points of the Diurnal Motions.—The general forms of the diurnal motion vary between rude ellipses and circles. In the winter months, the principal portion, or loop of the figures, is elliptical, with the major axis horizontal; near the equinoxes, the figure becomes somewhat circular, and in the midsummer months it again becomes rudely elliptical, with the major axis inclined about 20° or 30° west of the magnetic meridian. In the usual investigations of the conventional element of declination, it has been remarked, that the turning from the farthest westerly position occurs near the time of maximum temperature ; a coincidence which has been supposed to indicate a real connection, though there is no similar coincidence between the epoch of minimum temperature, and the eastern turning point. If, however, we examine the figures indicating the diurnal motions of a needle in its *true* position, such as those for the months of April, August, October, &c., we might find it difficult to say where is a turning point and where not ; and it is difficult to see why the turning points at the extremities of the horizontal diameters of these rude circles, or at the extremities of *a* horizontal line, in the ruder ellipses, should be chosen, in preference to the turning points at the extremities of other lines drawn in the figures, as tests for a theory ; unless, indeed, it be explained by the accident that a horizontal suspension of a magnetic needle, is a convenient one for observing a certain portion of the

motion of a magnet, which, independently of gravity, would rest in the direction of the magnetic force.

It has been customary, however, to give theories of the cause of magnetical variations, with reference solely to the diurnal variations of the magnetic declination (and not unfrequently with a very indifferent knowledge of the facts with respect even to that element). I venture to say, that it will only be from a careful comparison of the whole facts relating to the motions of a freely suspended dipping needle, not for one place, but for different and distant portions of the earth's surface, that a satisfactory theory will be obtained. The attempt to deduce one from a consideration of the declination variations alone, can only be likened to a similar attempt with reference to planetary motions, the apparent position of the planet being studied without any relation to the direction or rate of motion of the place of observation.

Dr Lloyd, who has done so much for magnetical science, has lately brought forward a discussion of his declination observations, which he considers strongly in favour of the theory that the diurnal variations of magnetic declination are due to the sun's heating effect upon the earth, in opposition to the atmosphere. I venture also to offer my guess, founded upon a consideration of various meteorological facts, that it is in the atmosphere, and not the earth, that we shall find seated the secondary causes of magnetic variations. In the meantime, it is *facts* that are wanted.

It may be noticed, chiefly with reference to the months from March to October, that a line passing through the positions of noon and midnight, also passes through, or nearly through, the mean position, or the centre of gravity, each hour having equal weight: also a line passing through the positions, about four hours before, and four hours after noon, passes nearly through the centre of gravity of the perimeters; the former of these lines lies nearly in the direction of the minor axis, the latter nearly in that of the major axis of the rude ellipses for the midsummer months. The horizontal line passing through the centre of gravity also passes nearly through the positions of 1^h A.M. and 1^h P.M., which, therefore are the epochs of mean dip.

Angular Distances between the Hourly Positions from the Mean of all, and from the Undisturbed Days.—In order to render the following result intelligible, it must be stated that, after a careful

examination of each day's observations in the years 1844 and 1845, a series was selected, in each month, of days nearly unaffected by magnetic irregularity; the diurnal variation was then obtained for these undisturbed days, and this was compared with the diurnal variation deduced from all the observations; the assumption being made that the mean for the whole 24 hours was unaffected by disturbance, the differences of the hourly values would evidently shew the effect of disturbance on the *hourly* mean position. This assumption, it was found, must be as nearly as possible true for the magnetic declination, because the monthly means of the selected days differed little or nothing from those of all the days; this, however, is not the case for the element of dip, the disturbance appeared to affect the daily or monthly mean to a small extent. Confining myself here to the result for the year (referring to the volume of the Transactions for the partial results which vary with season); the following numbers indicate the displacement of the mean hourly positions by disturbance, upon the assumption that the centre of gravity for each figure is the same :—

12^h	14^h	16^h	18^h	20^h	22^h	0^h	2^h	4^h	6^h	8^h	10^h	12^h
0·35	0′·25	0′·06	0′·15	0′·27	0′·30	0′·23	0′·31	0′·30	0′·17	0′·31	0′·39	0′·35

The diameter of the figure is little greater than 2′·0.

In the mean figure for the year (see Plate VIII. already referred to), minima occur at 4^h A.M. and about $5\frac{1}{2}^h$ P.M., the maximum occurs about 10^h P.M., and a maximum occurs between 8^h A.M. and 4^h P.M. If, making allowance for the effect of disturbance on the position of the centre of gravity with reference to dip, we suppose the centre of gravity of the dotted figure for the year, raised 0′·15 on the line of mean declination, or that of the continuous figures lowered as much, we find the maximum effect of disturbance to occur about 10^h P.M. and 10^h A.M., and the minimum effect about 4^h A.M. and 5^h P.M. This result was obtained for the magnetic declination in 1844, and is given in the volume for that year.

Motions with reference to the Moon's Hour-Angle.—These, as obtained from the means of all the lunations in the years 1844 and 1845, and as deduced from winter lunations for 1845 only, are shewn in Plate VII. The resulting figures, especially that for the winter lunations of 1845, bear some resemblance to the diurnal motion for the month of December.

Aurora Borealis.

A table of 184 auroræ seen at Makerstoun in years 1843 to 1849 is given in pages lxxv.–lxxviii. of Vol. xix., Part 2; from this table the following results have been obtained:—

A very careful outlook for auroræ was kept throughout the whole period, but especially during the first five years; an outlook warned by magnetic disturbance in circumstances unfavourable to the visibility of the meteor, and assisted by a practical acquaintance with the faintest auroral indications. In several cases, the auroral appearances were very faint; these are entered in the table as "Traces," and, in others, there was doubt whether the appearance was truly auroral; these are indicated by "Trace?" It should be noted that, with the exception of the years 1844 and 1845, auroræ were seldom looked for after midnight.

Diurnal variation of frequency of the Aurora Borealis.—The following are the numbers of times which auroræ were seen, at each hour, from 5^h P.M. till 5^h A.M., for the whole period—referring to the printed tables for the numbers for each season.

Hour,	5^h	6^h	7^h	8^h	9^h	10^h	11^h	12^h	13^h	14^h	15^h	16^h	17^h
No.,	5	19	45	57	91	75	50	37	27	15	11	3	2

The greatest number of auroræ were seen at 9^h P.M.; this result is independent of the effect of twilight, since 9^h P.M. is also the hour of maximum frequency for the winter months. This hour is nearly the hour of maximum disturbance for the magnetic declination and dip; as, however, the maximum disturbance of the total magnetic force and a maximum of the magnetic dip appear to occur about 5^h P.M., this also may be an epoch of maximum frequency or intensity, though this can only be determined in higher latitudes. It should also be remarked, that, since the epoch of maximum disturbance varies with season, so, therefore, it is probable will that of frequency of the aurora; some traces of this may be deduced from the previous table. In the winter quarter, November–January, four-fifths of the times at which auroræ were seen were for the hours *before* 10^h P.M., whereas in the spring quarter there were only three-fifths seen before 10^h P.M.

Annual Variation of frequency of the Aurora Borealis.—The first line following contains the numbers of auroræ observed in each month during the six complete years 1843–8, and the second line gives the numbers of hours at which the auroræ were seen.

Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
15	16	26	14	6	0	0	7	13	27	23	11
50	62	65	43	8	0	0	10	32	44	58	38

The greatest number of auroræ were observed in March for the first six months, and in October for the last six months of the year: none were observed in June and July. When the six months of 1849 are included, the number for February is 26, and for March, 28. The law of visible frequency of the aurora is the same as that deduced already for magnetic disturbance; namely, maxima near the equinoxes, and minima near the solstices, the minimum at the summer solstice being the principal. As, however, the shortness of night during the summer months must diminish the number of visible auroræ, it is by no means certain from these numbers that a minimum occurs at the summer solstice; the fact of the minimum at the winter solstice is involved in no such difficulty. If we could assume that the auroræ had the same diurnal law of frequency at all seasons of the year, the existence of the summer minimum could be satisfactorily determined, by comparing the numbers of times which auroræ were seen at the five hours, 10^h P.M.–2^h A.M., during which (even in the months of August and May) there is little twilight to extinguish auroræ. The numbers are as follow, for these five hours in each month of the years 1843–8 :—

Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
15	24	38	31	8	0	0	9	14	16	18	12

From these it is evident that the numbers in May and August are certainly less than for April and September; but it has been already mentioned as probable that the diurnal law of frequency varies with season, of which, indeed, a proof is to be found in the great excess of the numbers above for the spring months, compared with those for the autumn months, shewing the later epoch of the maximum frequency in the former. An examination, however, of the table for the disturbance of the magnetic declination (Table 18, Vol. xix., Part 2), will shew that, though the maximum disturbance occurs after midnight, in the months of May, June, and July; yet in August and the two following months it occurs about 10^h P.M., so that there can be no doubt of the less number for August than for September and October, if there should be a doubt in the case of May compared with April. The difference, however, even in the latter case is too great to be explained by any slight shift of the epoch of maximum

frequency in the two months. Upon the whole, it appears certain that a minimum of actual as well as of visible frequency occurs in summer; a result quite in accordance with that for the amount of magnetic disturbance, which accordance is sufficiently close to permit us to complete it, by assuming that the number of auroræ is a *principal* minimum in summer.

It has been stated in the volume for 1844, p. 401, that this result was long ago obtained by Mairan; this statement, made chiefly on the authority of Kæmtz and Hansteen, is not quite accurate. It is true that Mairan's numbers give a rough indication of the law, as will be seen below; but when it is remembered that his table includes all the observations (229) of which he could find a record for upwards 1000 years, it will be evident, that the conclusion that a greater number of auroræ occurred at both equinoxes than at the winter solstice would have been hasty; this conclusion, however, is *not* made by Mairan, and, though he has combined the numbers of auroræ in a great variety of ways, he has made no combination exhibiting this fact. It did not enter into the necessities of his theory (that auroræ are the product of the solar atmosphere) to shew that a greater number of auroræ happened in the northern hemisphere at the vernal equinox than at the winter solstice; he shews, indeed, that the number for one equinox is, and, in accordance with his theory, ought to be, greater than for the other. Some other philosopher has the merit of first pointing out this fact.

The following are the numbers of auroræ by Mairan (Traité Physique et Historique de l'Aurore Boreale, par M. de Mairan, 1733, p. 199); by Kæmtz (Complete Course of Meteorology, translation by Walker, p. 458); and by Hansteen (Mem. de l'Acad. Roy. de Belgique, t. xx., p. 117).

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Sum.
Mairan, .	21	27	22	12	1	5	7	9	34	50	26	15	229
Kæmtz, .	229	307	440	312	184	65	87	217	405	497	285	225	3253
Hansteen, .	29	31	47	34	2	0	0	17	35	33	34	23	285
J. A. Broun,	22	26	28	16	6	0	0	7	16	29	23	11	184
Sum of last three,	280	364	515	362	192	65	87	241	456	559	342	259	3722

Mairan's numbers are probably included by Kæmtz; a few of the auroræ, included in M. Hansteen's list, are identical with those in my own.

Variation of Frequency of the Aurora Borealis with the Moon's Age.—This investigation is evidently beset with considerable difficulty, since the moonlight existing nearly extinguishes the appearances of all the fainter class of auroræ, and it renders the faintest wholly invisible; the careful watch, however, which was kept for auroral appearances at Makerstoun, probably renders the table given in the Transactions better fitted for such a question than any previous series of observations.

It should be remarked, that the latitude of Makerstoun, or perhaps even a lower latitude, is better fitted for this investigation, than much higher latitudes; at least this is the case as long as only frequency of visibility can be considered. The French *Commission du Nord*, during their stay in Lapland, found auroræ existing, or probably existing, almost every night. In such places variation of frequency there is none, and variation of intensity alone remains for investigation. It is obvious, that till some better mode of measuring this intensity can be devised for these high latitudes, we are forced to perform this operation in a rude manner, by moving to lower latitudes, where the fainter auroræ become invisible, and where, therefore, frequency is a test of intensity beyond a certain limit.

Combining the numbers of auroræ observed at each day of the moon's age into six groups of 5 days (the first group, 4½ days), we find the average number of auroræ for one day of the moon's age in each group as follows, from the 6½ years' observations:—

Moon's age.	28^d—2^d	3^d—7^d	8^d—12^d	13^d—17^d	18^d—22^d	23^d—27^d
Number.	5·8	5·2	3·6	5·0	10·2	6·6

Did auroræ *occur* indifferently at all ages of the moon, we should expect to *see* the greatest number at conjunction, and the least number at opposition; this, however, is not the case, the greatest number was seen about two days before the end of the third quarter, and the least number about two days after the first quarter, or the visible maximum and minimum occurred at times *equidistant* from the epoch of opposition. The frequency of auroræ, therefore, is a function of the moon's age. In order to determine the actual law, we may consider the probable effect of moonlight in obliterating the auroral appearances; remarking, first, that 9^h P.M. is the epoch of maximum frequency for the aurora, and that upwards of five-sixths are seen before midnight. When the moon is about three days old, in the months from September to March, it begins to set sufficiently

late, and to have sufficient light to render the earlier of the faint auroræ invisible; about the end of the first quarter, it does not set till midnight, and thus shines throughout the period of the occurrence of five-sixths of the auroræ; afterwards it increases in brightness, and the maximum effect in extinguishing faint auroræ is evidently attained at opposition, when the moon begins to rise late enough to allow the earlier auroræ to be visible; towards the end of the third quarter, when the moon does not rise till midnight, it is also evident that the number of faint auroræ rendered invisible must be very small. From the beginning of the fourth quarter, therefore, till conjunction, the numbers *seen* will obey nearly the true law of frequency; and as the visible maximum occurred before the end of the third quarter, the true maximum must have occurred even nearer to opposition. On the whole, it appears very certain, that the hypothesis of an actual maximum of frequency at opposition, and minimum at conjunction, is satisfied by the previous numbers of auroræ, seen under the conditions of the varying duration of moonlight for the hours of maximum frequency. This hypothesis is in unison with the law of magnetic disturbance, which is a maximum at opposition, and a minimum at conjunction.

Note on the Theory of the Aurora.

Although temptations to frame hypotheses have been avoided hitherto, I cannot refrain from repeating here the opinion, that the phenomena of the aurora borealis are chiefly optical.

After watching the various phases of the aurora for some years, the hypothesis of self-luminous beams and arches appeared to me unsatisfactory; and the strongest argument in its favour, that obtained from the computed height of the auroral arches, seemed of a very doubtful character. I was quite prepared, therefore, to adopt the idea, first I believe proposed by M. Morlet to the French Academy, in May 1847, that the auroral arch is an optical phenomenon of position. M. Morlet has pointed out that the arch appears generally as a segment of a circle; whereas, in these latitudes, it ought invariably to appear as the segment of an ellipse, if the hypothesis be true of a real luminous ring, with its centre on the continuation of the magnetic pole. He has also, among many other very obvious objections to that hypothesis, shewn that the summit of the arch is generally in the magnetic meridian of the place, the plane of which

rarely passes through the magnetic pole, and seldom passes through the same point, for three different places. I have, however, felt even more persuaded that the aurora is, partly at least, an optical phenomenon, from a consideration of that phase of the aurora constituting the corona borealis, a persuasion that I stated in the Literary Gazette of the time, in giving an account of the beautiful corona of October 24, 1847.

Mairan, and, more lately, Dalton, have explained this phase of the aurora by a hypothesis of polar beams, long fiery rods of solar atmosphere, according to the one, of red-hot ferruginous particles, according to the other, seen in perspective, as they lie in the direction of the magnetic force. A little acquaintance with the phenomenon—the rushing and tilting of the beams against each other, one beam occasionally rising from the horizon, passing through the centre of the crown and beyond it—would shew the improbability of this hypothesis. I am persuaded, that the phenomena of the corona borealis is produced in a narrow horizontal stratum of the earth's atmosphere. Thanks to the discoveries of Dr Faraday, we do not require a ferruginous sea, in order to have polarized particles; the watery crystals that inhabit the upper regions of the atmosphere can themselves assume a polar state, determined by the passage of electric currents; and we have only to complete this fact by a hypothesis of luminous electric discharges seen refracted by these crystals, the position of visibility of the refracted rays depending on the angles of the crystals, and the deflections from the direction of the magnetic force which they suffer, by the electric currents. Such a hypothesis, which occurs at once when an optical phenomenon has to be accounted for, would explain these remarkable auroral clouds, so often seen in connection with the aurora itself; it would also serve to explain the appearance of the arch at certain altitudes, lower for lower altitudes, determined by the position of the source of light, direction of the magnetic force at the place, and the effect of the electric current in deflecting the crystals. The crystals successively deflected by electric currents would also exhibit the rushing pencils or beams.

It need scarcely be remarked, that differently formed crystals might give rise to different phases of the phenomenon; while reflection might be combined with refraction in certain cases, especially in the case of arches seen south of the anti-dip. Such a hypothesis evidently assumes a source of light, independent of these optical re-

sultants, and the pulsations seen in many auroræ may be real luminosities.

It is hazardous, in the present ill-arranged state of auroral observation, to offer so rude a sketch of a new hypothesis, although we may suffer a considerable defeat in very good company.

Since the previous note was written, I find that M. Morlet has published a theory of the auroral arch (Ann. de Ch., t. xxvii., 3me Série). The ideas above were stated by me two years ago, to different persons.

The following Donations to the Library were announced:

Transactions of the Royal Scottish Society of Arts. Vol. III., Part 4. 8vo.—*By the Society.*

Journal of the Asiatic Society of Bengal. Edited by the Secretaries. N. S. No. 32. 8vo.—*By the Society.*

Annali di Fisica dell' Abbate Francesco Car. Zantedeschi. Fascicolo 4. 8vo.—*By the Author.*

Quarterly Journal of the Chemical Society. No. 9. 8vo.—*By the Society.*

Scheikundige Onderzoekingen gedaan in het Laboratorium der Utrechtsche Hoogeschool. 5de Deel. 6th Stuk. 8vo.—*By the University.*

Bulletin de la Société de Géographie. 3me Série. Tom. 12me. 1849. 8vo.—*By the Society.*

ERRATUM,

Vol. II., No. 33, page 205, line 12 from bottom,

For " These data are (1.)," &c., *read* " These data are (1.), The known expansion of water in freezing; (2.), The known quantity of heat which becomes latent in the melting of ice; and (3.), The quantity of work given out," &c.

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